Textile Image Retrieval Using Composite Feature Vectors of Color and Wavelet Transformed Textural Property

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Agenda

- Motivation
- Research Goals
- Related Works
- Proposed Method
- Experimental Results
- Concluding Remarks

Motivation

- Content Based Image Retrieval (CBIR) is a process of retrieving desired image from a large collection of images based on the features such as color, shape and texture that can be extracted from the image themselves.

- Color is widely used for identifying images but color histogram has a limitation to carry local spatial information of pixels even though its efficiency. Meanwhile, in transform domain some high-level features can be extracted.

- Texture is one of the most important attributes used in image analysis because it contains structural arrangement of textile surfaces and their relationship to the surrounding environments.

Research Goal

- We present a hybrid approach for content-based textile image retrieval which uses composite feature vectors of color feature from spatial domain and second-order statistic features from wavelet-transformed sub-band coefficients.

- Extract texture features such as contrast, homogeneity, ASM(angular-second momentum) and entropy from decomposed sub-band images by wavelet transform.

- Develop an image retrieval system which uses those multiple feature vectors with color histogram.

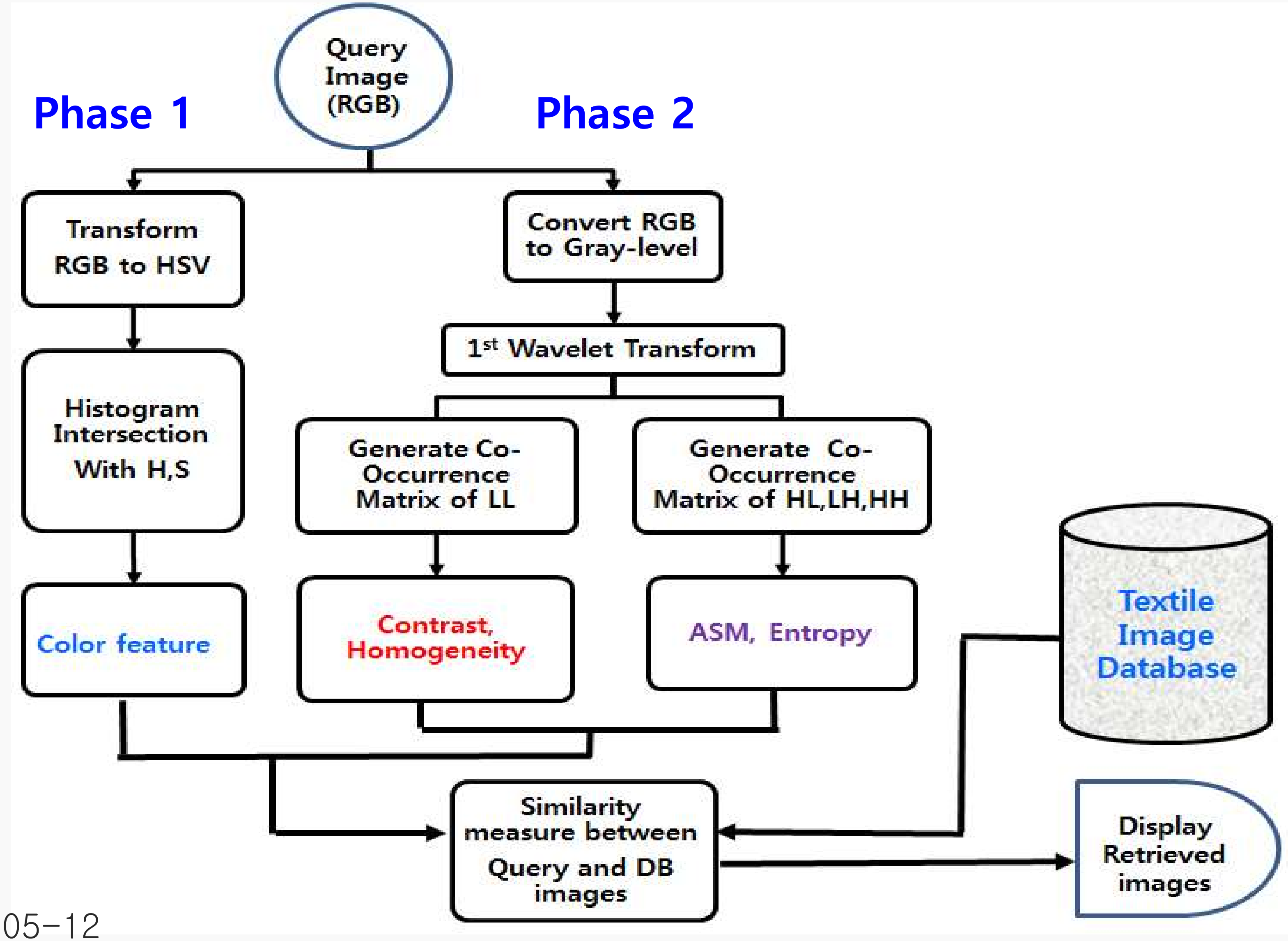
Related Work

Use Wavelet Transform for Image Retrieval.

- In early stage of the applications of wavelet transform for CBIR Gabor wavelet is widely used for extracting texture features for image retrieval since the scale and orientation tunable property of Gabor filter makes it useful for texture analysis[1,2].

- Coefficients derived from Daubechies wavelet is used for pattern recognition with neural network because of its fast computation and regularity[3].

The Proposed System Overview



Color Feature Representation(1)

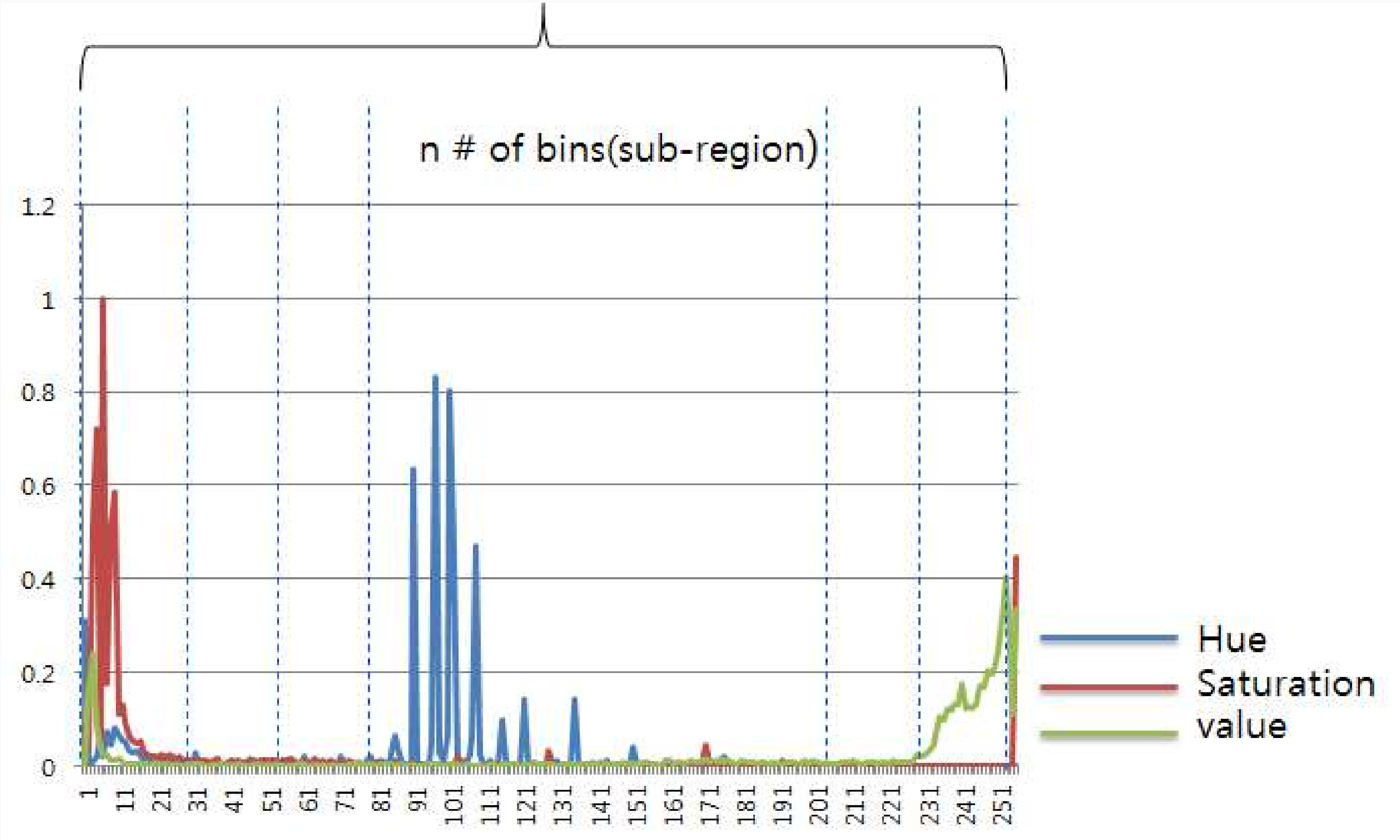
- We use HSV color model rather than using RGB to extract color histogram.

- The histogram intersection $H_\cap$ which provides the similarity measure between each image (***i***) in the database and query image(***q***) can be defined as

$$H_\cap = \sum_{j=1}^{n} \min\left(H_i^j, H_q^j\right)$$

- Here, ***j*** is histogram bin, ***n*** is the total number of bins for each histogram, ***Hi*** and ***Hq*** are histograms of database and query image, respectively. The closer value of is to ***1*** the better images match.

Color Feature Representation(2)



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Wavelet Decomposition(1)

- Wavelet transform is a multi-resolution representation that presents image variations at different scale since each frequency component can be analyzes with different resolution and scale.

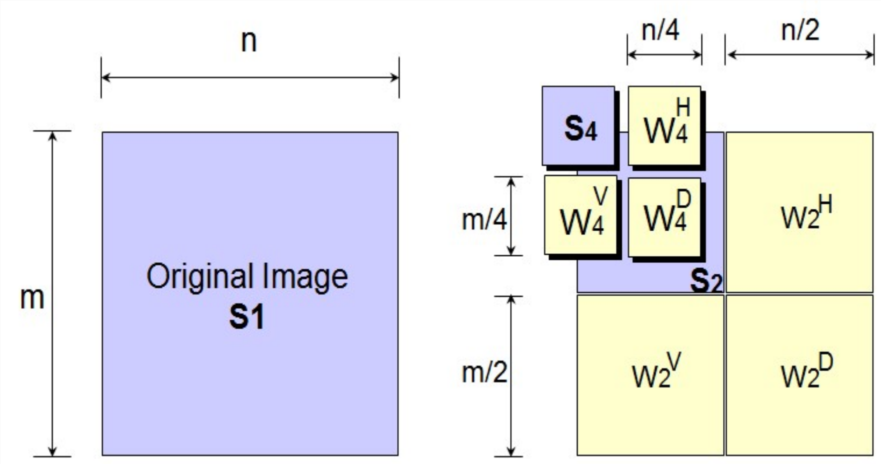
- The continuous wavelet transform (CWT) decomposes a signal ***f*** into a set of scaling functions by using a wavelet function basis:

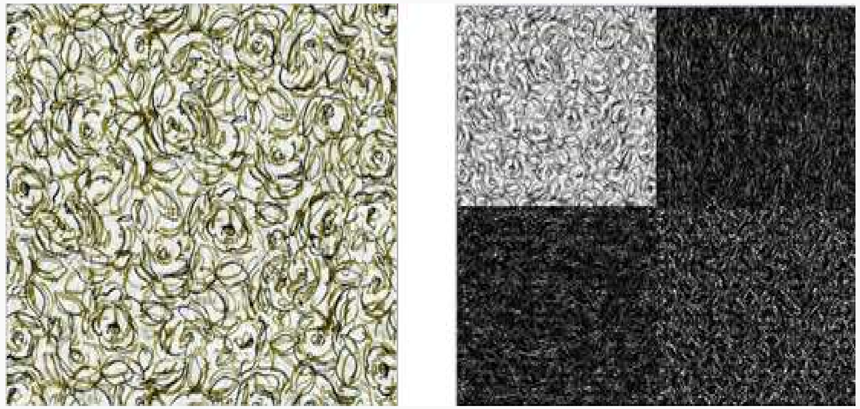
$$(W_a f)(b) = \int f(x)\psi_{a,b}(x)dx$$

$$\psi_{a,b}(x) = \frac{1}{\sqrt{a}}\psi\left(\frac{x-b}{a}\right)$$

Wavelet Decomposition(2)

1st level wavelet transform a textile image.





- **The decomposed sub-band images are labeled as S_2 (LL), W_2^V (LH), W_2^H (HL) and W_2^2 (HH), where L and H represent low and high frequency, respectively.**

- **From these decomposed sub-bands, we can obtain detail local information about the original image.**

Texture Feature Representation(1)

- In order to extract better local information we use co-occurrence matrix **C(i,j)** from the wavelet decomposed sub-band images.

$$C(i,j) = \sum_{x=1}^{N}\sum_{y=1}^{N}\begin{cases} 1, & if \quad I(x,y)=i \quad and \quad I(x+\delta_x, y+\delta_y)=j \\ 0, & otherwise \end{cases}$$

- The offset (δ_x, δ_y) is specifying the distance between a specific pixel and its neighbor pixels.
- It is known that the offset (δ_x, δ_y) parameterization makes the co-occurrence matrix sensitive to rotation.
- Thus choosing an offset vector, such that the rotation of the image is not equal to 180 degrees, will result in a different co-occurrence matrix for the same (rotated) image.

Texture Feature Representation(2)

- From the gray-level co-occurrence matrix (GLCM) contrast, homogeneity, ASM(Angular Second Momentum) and entropy are evaluated.

- Contrast and homogeneity presents the difference or similarity in light between parts of the image meanwhile ASM and entropy are the statistical measures of the randomness of the input image.

Texture Feature Representation(3)

- If $P(i,j)$ is the entry of GLCM and N_g is gray-level then the contrast, homogeneity, ASM, and entropy can be defined respectively as:

Contrast

$$\sum_{n=0}^{N_g-1} n^2 \sum_{i=1}^{N_g} \sum_{j=1}^{N_g} p(i,j), |i-j| = n$$

Homogeneity

$$\sum_{i=1}^{N_g} \sum_{j=1}^{N_g} \frac{p(i,j)}{1+n^2}, |i-j| = n$$

ASM

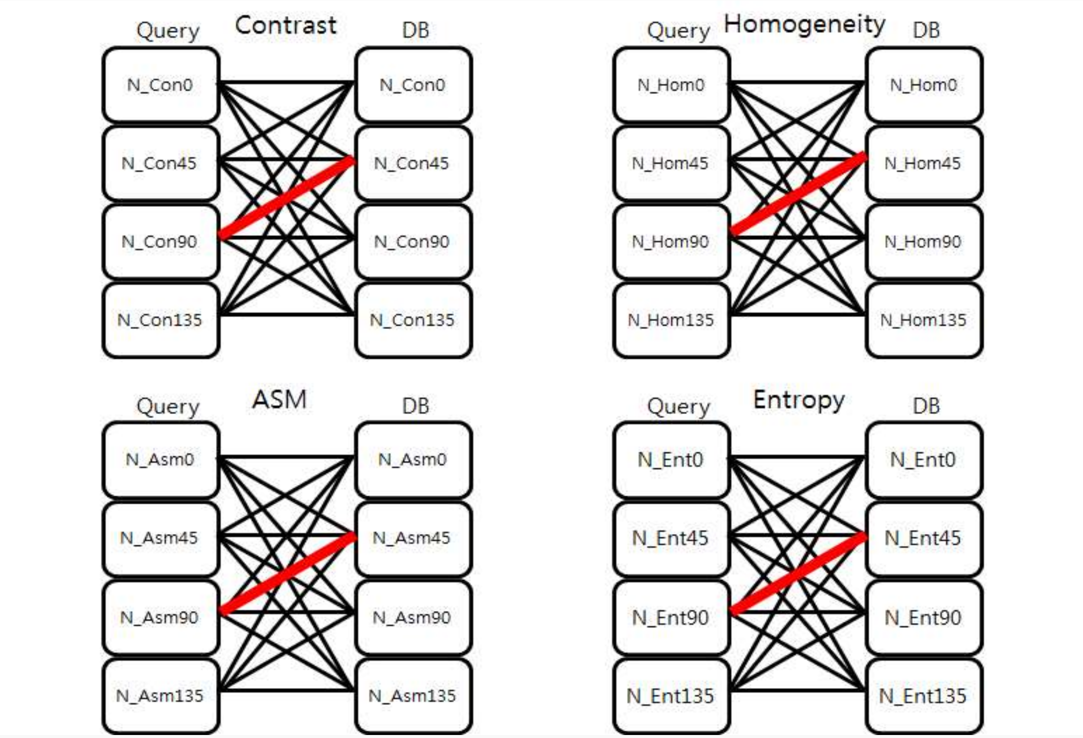
$$\sum_{i=1}^{N_g} \sum_{j=1}^{N_g} p^2(i,j)$$

Entropy

$$-\sum_{i=1}^{N_g} \sum_{j=1}^{N_g} p(i,j) \ln(p(i,j))$$

Experimental Results(1)

- We use 1343 cases of textile image.
- Texture information evaluated from the wavelet transformed domain consists of 16 vector-valued features since 4 textural directions of $0°, 45°, 90°, 135°$ are considered from the GLCM.



Experimental Results(2)

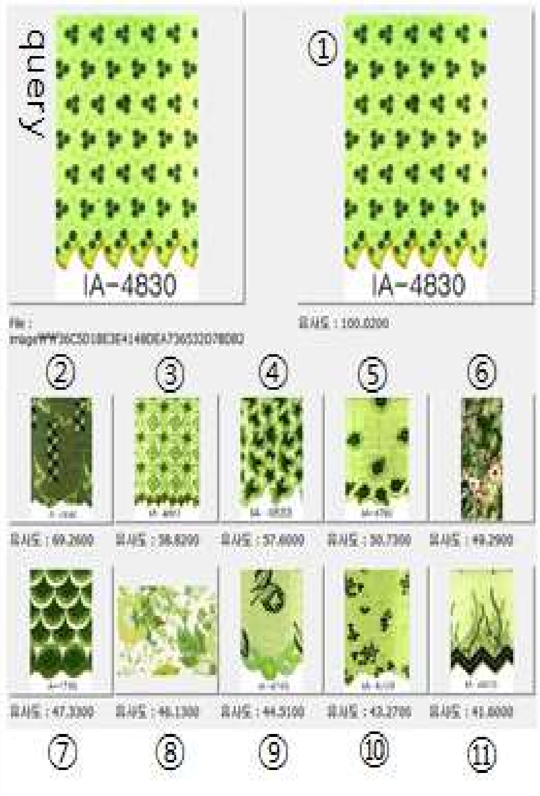
- Thus the total texture similarity **(TS)** from wavelet transformed domain becomes

$$TS = N\_Con_{k,l} + N\_Hom_{k,l} + N\_Asm_{k,l} + N\_Ent_{k,l} \quad \text{for } \forall \quad k,l = 0°,45°,90°,135°$$

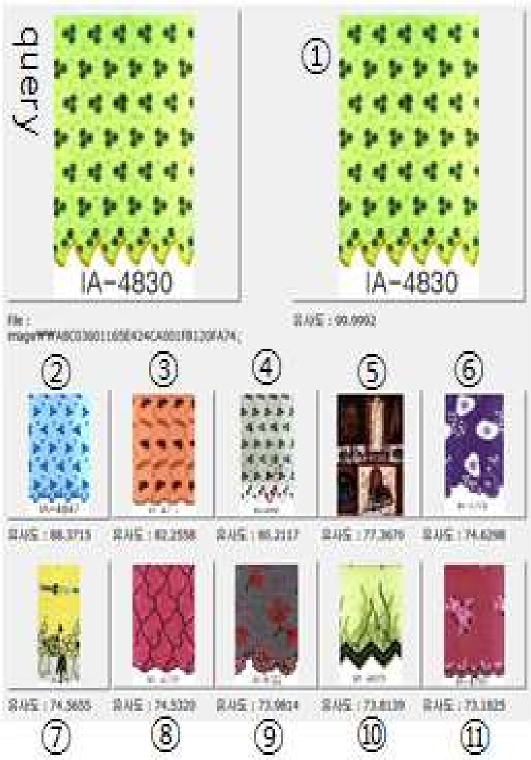
- The similarity measure S_{iq} between a query **(q)** and a database image **(i)** is evaluated as follow when color similarity CS_{iq} , texture similarity TS_{iq} , and a control ratio α are provided.

$$S_{iq} = \left(CS_{iq} \times \frac{\alpha}{100} \right) + \left(TS_{iq} \times \frac{(100-\alpha)}{100} \right)$$

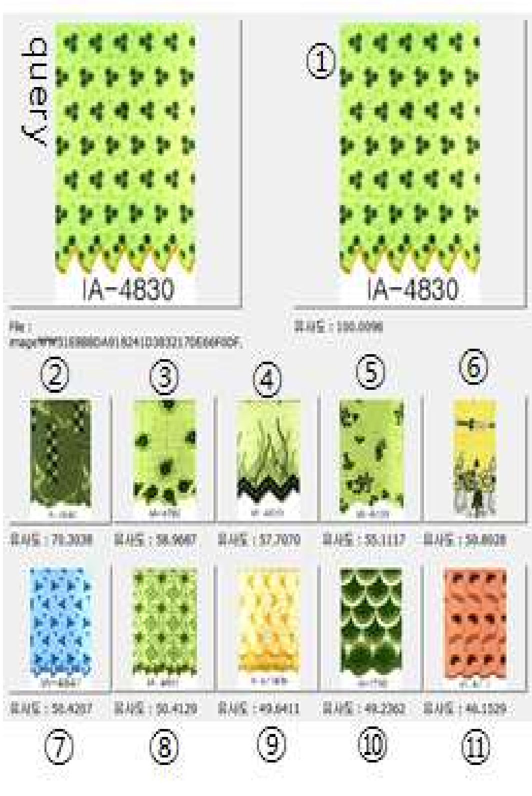
Experimental Results(3)



$\alpha = 100$



$\alpha = 0$



$\alpha = 50$

Experimental Results(4)

$\alpha = 100$

$\alpha = 0$

$\alpha = 50$

Experimental Results(5)

Color 20 %, Texture 80%

Color 20 %, Texture 80%

Concluding Remarks

- We propose a hybrid content-based textile image retrieval approach which uses composite features of color from spatial domain and texture from wavelet-transformed domain.

- While applying texture features such as contrast, homogeneity, ASM and entropy from wavelet decomposed sub-band images, we can guarantee the rotational-invariant of images.

- From the experiments we can prove the efficiency based on these multiple textural feature vectors with HS color histogram to retrieve the desired images from a large set of textile image database.

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