Vol 6 Issue 10 July 2017

ISSN No : 2249-894X

Monthly Multidisciplinary Research Journal

Review Of Research Journal

Welcome to Review Of Research

RNI MAHMUL/2011/38595 **ISSN No.2249-894X**

Review Of Research Journal is a multidisciplinary research journal, published monthly in English, Hindi & Marathi Language. All research papers submitted to the journal will be double - blind peer reviewed referred by members of the editorial Board readers will include investigator in universities, research institutes government and industry with research interest in the general subjects.

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REVIEW OF RESEARCH

ISSN: 2249-894X
IMPACT FACTOR : 3.8014(UIF)
VOLUME - 6 | ISSUE - 10 | JULY - 2017

CLOTH PATTERN RECOGNITION AND COLOR IDENTIFICATION TECHNIQUES: REVIEW

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ABSTRACT :

In today's era, image processing techniques are becoming useful for various applications. For visually impaired or blind individuals, it is not possible to recognize pattern or colors of cloths they use. Image processing approach can be useful for cloth pattern recognition as well as cloth color identification. Various approaches are used by researchers for the same. The present study discusses about difference between traditional texture samples and clothing pattern samples with large intra class pattern and color variations, various statistical analysis methods used for pattern recognition, directionality of image using Radon Signature and color identification techniques. Clothing patterns of four different categories are considered here (stripped, plaid, irregular and pattern-less) and color identification is considered in terms of percentage of 15 different colors. Using MATLAB tools for image processing, special functioned descriptors can be implemented to extract image features. Also colors can be identified by normalizing the histogram in HSI (Hue, Saturation and Intensity) color space. Large database of different cloth pattern images is required for comparative analysis.

KEYWORDS : *clothing pattern recognition, texture analysis, radon signature, HSI color space, sobel operator, histogram.*

I.INTRODUCTION:

Image processing is now-a-days have taken immense importance in every possible field of application. Researchers find it challenging to implement image processing techniques for various applications and get results accordingly. Many of the applications are being implemented keeping disability of visually impaired or blind people in mind [1], [2], [3], [4], [5], [9], [20], [21], [22]. Efforts have been made to make their life less difficult. Face recognition systems, letters or words identification systems, etc. have been implemented by many of the researchers. One such application is recognition of cloth pattern and identification of its color. Even while choosing cloths from their own wardrobes, visually impaired people usually depend on others or use various stitching tags or some special kind of braille plastic labels.

The camera based systems is considered here with all feasible inputs and outputs for a visually impaired person (see Fig.1). The system mainly consists of three parts: 1) Sensors (Camera, Microphone and Earphones), 2) Data capture and analytics (a computer based system with MATLAB or some DSP controller with image processing capability) and 3) Audio output and system control related input outputs. Camera captures the image of cloth; microphone or earphone takes voice command from user. Computer or mini-computer or DSP processor carry out actual implementation of algorithms and generate results. It also consists of large dataset of cloth images of different patterns for comparative analysis of input image. Speakers give audio output of the result.

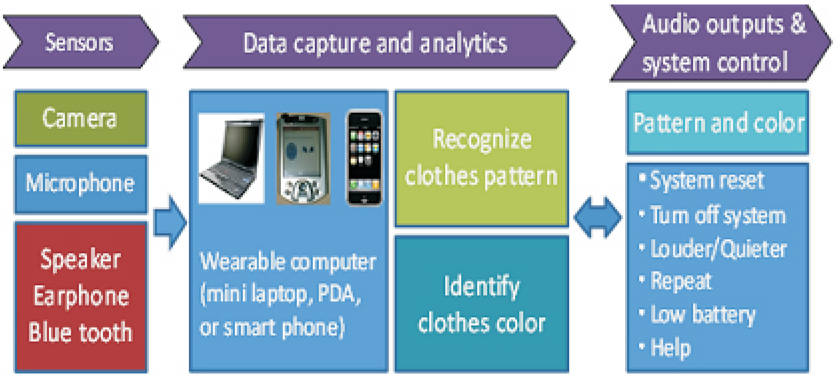


Fig. 1. Overview of the considered camera based system

Research on this topic has been reported to start in mid 1980s from Japan. With time various attempts have been reported throughout the world. Initially, more focus was made by researchers on texture analysis of scaling and in-plane rotation of global 2-D images. Variance in general geometric transformations was not considered in this type of approach. To overcome this 3-D transformation was introduced and with time non-rigid surface deformations, viewpoint changes, variance in illumination got introduced. Most recent add-on is to extract local features of the image.

Even after all these improvements, texture analysis cannot give satisfactory because of the large intra class variations in the image [6], [8], [11], [12], [15] (see Fig.2). The technique was later introduced to overcome these variations by using combination of global and local features of the image. The features are extracted by using detectors and descriptors. Radon transform gives global directionality, whereas global statistical features are obtained by using STA. Local features are obtained using SIFT, RQA, Mathematica morphology, etc.

The techniques considered here are capable of identifying four patterns: Striped, Plaid, Pattern-less and Irregular [1], [2], [3]. Also identifying 11 colors: green, yellow, orange, blue, pink, red, cyan, purple, gray, black and white.

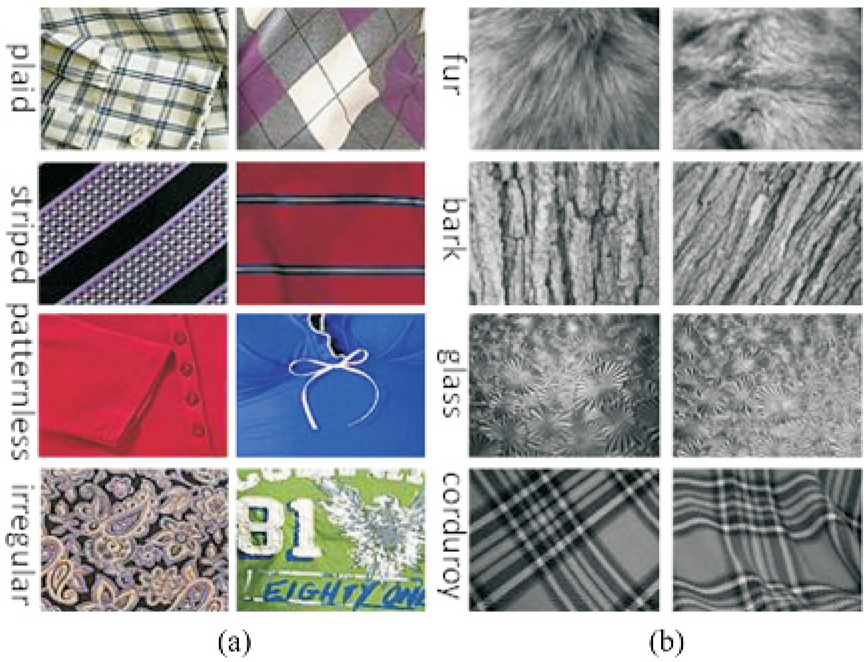


Fig. 1. (a)Cloth pattern samples with large intra class pattern and color variations. (b)Traditional texture samples with less intra class pattern and intensity variations.

This paper is organized as follows: Section-II contains related work for this topic in brief. Section-III contains information of pattern recognition and feature extraction of cloth pattern. Section-IV contains the methodology of color identification. Section-V contains the conclusion of the system.

II. RELATED WORK

To make blind or visually impaired people's life better, many attempts have been made till date [1], [2], [3], [4], [5], [9], [16], [21]. Specifically, for texture analysis also the work has been done [6], [11], [12], [15], [19], [23], [24]. They effectively able to detect large variations in image orientation, viewpoint and scaling.

In order to rectify the problems in texture analysis (typically large intra class variations), few researchers came up with new methods [1], [2], [3]. To detect global directionality of the image, they used Radon transform (Radon Signature); global statistical features they identified with the help of STA on wavelet sub-bands and SIFT (Scale Invariant Feature Transform) and BOW (Bag of Words) histograms were used to detect local features of the image [1]. Recurrence Quantification Analysis (RQA) make use of recurrence rate and recurrence plot to extract local features [2]. It is possible to implement topological operations to find local features with the help of mathematical morphology [3]. Combination of local and global features gives better results.

III. CLOTHING IMAGE PATTERN RECOGNITION AND FEATURE EXTRACTION

In order to effective cloth pattern recognition local and global features both play key roles. Clothing patterns are basically the repetition of few basic primitives [7]. The structural information of basic primitives is extracted using local features of the image. But within same clothing pattern it is possible to observe significant variations in local primitive's due to large intra class variations. Within the same category global directionality and global statistical properties seem to be more stable. So they can give complementary information about local structural features and they can be extracted using descriptors [17], [18]. Following are the methods to extract local and global features of the image.

A. Radon Signature

Key consideration during cloth pattern recognition is that clothing images consists of large intra class variations. Also, the directionality of cloth patterns can be used as a significant property to identify various cloth patterns. The irregular and pattern-less cloth patterns are both isotropic. However, the cloth patterns striped and plaid are anisotropic. Directionality feature of clothing patterns are categorized by a new descriptor: Radon Signature (see Fig. 3).

RadonSig (Radon Signature) identifies the principle orientation of an image [10] based on Radon transform. In order to achieve rotation invariance, the image is rotated in accordance to dominant direction, Projection line and angle of projection 'theta' plays important role during Radon transform.

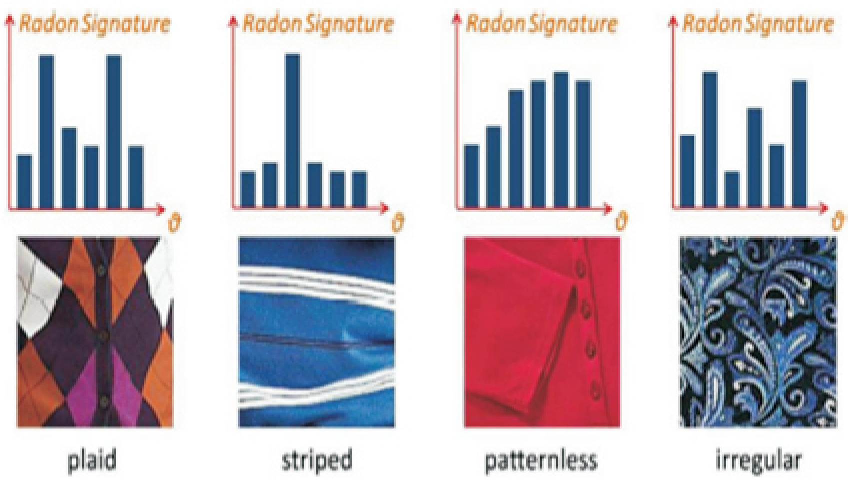


Fig. 3. Pattern and its Radon Signature.

Radon transform of 2D function f(x,y) is represented as,

$$R(r,\theta) = \int_{\infty}^{-\infty}\int_{\infty}^{-\infty} f(x,y)\delta(r - x\cos\theta - y\sin\theta)dxdy \qquad (1)$$

Where 'r' is perpendicular distance of projection line to origin and 'θ' is angle of projection line (see Fig. 4(b)). It is possible to compute Radon transform on maximum disk mask of the image instead of full image in order to retain the consistency. Gradient map as f (x,y) is calculated using Sobel operator in order to reduce intensity variations. Radon transform R (r, θ) in (1) is shown in Fig.4(c) with respect to two parameters 'r' and 'θ'. Variance of projection line r under some projection angle θ represents directionality of the image an is represented as Var ®, θ).

$$Var(r,\theta_i) = \left(\frac{1}{N}\right)\sum_{j=0}^{N-1}\left(R(r_j,\theta_i) - \mu(r,\theta_i)\right)^2 \qquad (2)$$

$$\mu(r,\theta_i) = \left(\frac{1}{N}\right)\sum_{j=0}^{N-1} R(r_j,\theta_i) \qquad (3)$$

Where μ (r,θ_i) is expected value, N gives number of sampling bins in each projection line. To calculate Radon transform it is necessary to find out variance of r under all sampling projections θ.

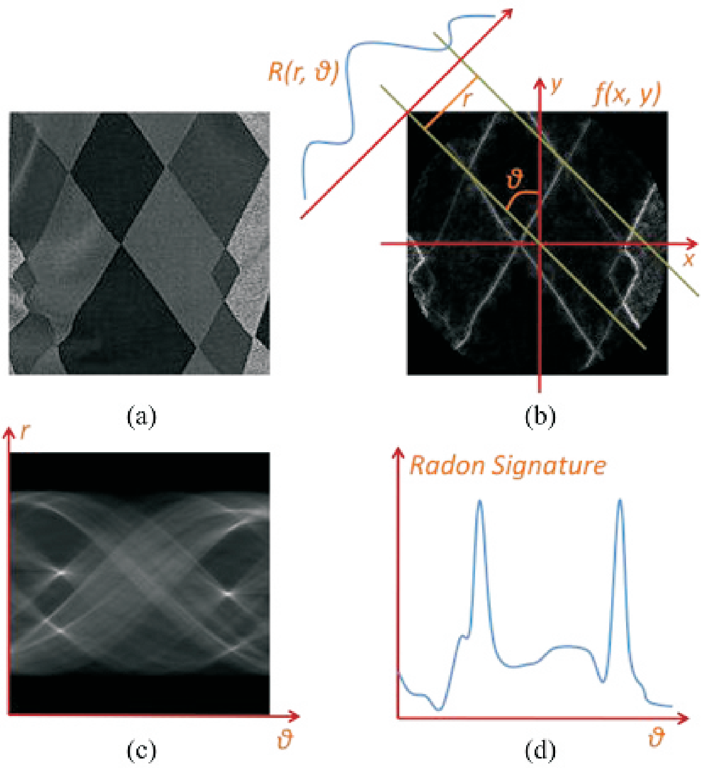


Fig. 4. Radon Signature. (a) Intensity image of cloth pattern. (b) Radon transform performed on maximum disk mask within gradient map of (a). (c) Radon transform result. (d) Feature vector of RadonSig

As we can see in Fig.3, Striped pattern possesses one principle orientation whereas Plaid pattern possesses two. Pattern-less and irregular patterns possess no such dominant orientation or direction but irregular pattern have much variations in directionality as compared to pattern-less.

B.Statistical (STA) feature extraction

Statistical features can effectively analyze textures [8] having uniform statistical properties but absence of background clutter. Wavelet transform generalizes multi-spectrum analysis. DWT stands for Discrete Wavelet transform and it performs statistical feature extraction and it decomposes image pixel into low pixels (see Fig.5). DWT delivers a simplification of a multi resolution spectral analysis tool. Hence, wavelet sub-bands are used to extract the statistical features and it results in releasing global statistical information of images at altered scales. To classify image, STA uses 4 features: variance, energy, entropy and uniformity. It is expected to calculate the distinct energy value on each sub-band.

Clothing image goes through three levels of wavelet decompositions where individual level of decomposition possesses four wavelet sub-bands of original, diagonal, horizontal and vertical components. It is mandatory to calculate individual energy value on every sub-band. Four statistical values are dominant here namely energy, entropy, variance and uniformity. They can be calculated using below equations:

$$Energy = \sum_{i=0}^{L-1}(z_i - m)^3\, p(z_i)/(L-1)^2 \quad (4)$$

$$Entropy = \sum_{i=0}^{L-1} p(z_i)\, log_2 p(z_i) \quad (5)$$

$$Variance = \sum_{i=0}^{L-1}(z_i - m)^2\, p(z_i)/(L-1)^2 \quad (6)$$

$$Uniformity = \sum_{i=0}^{L-1} p^2(z_i) \quad (7)$$

Where, $p(z_i)$ and z_i, i = 0,1,2,. . . , L-1 is the histogram of intensity level and corresponding intensity level respectively. L is number of intensity levels and m is average intensity level.

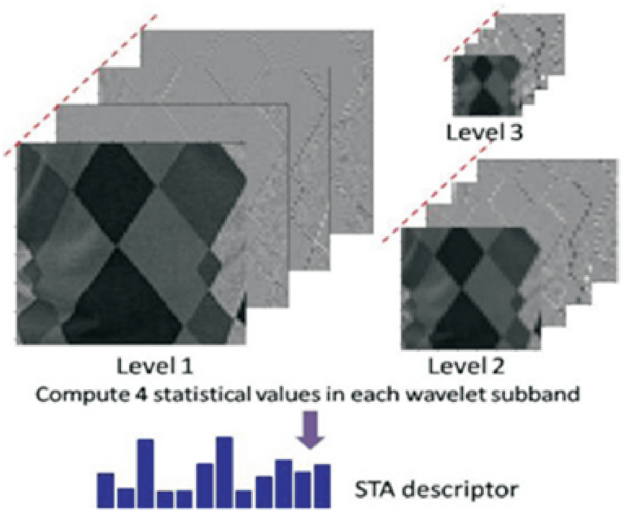


Fig. 5. The calculation of STA on Wavelet sub-bands.

C.Scale Invariant Feature Transform

To carry out smoother pattern recognition, it is necessary that the local and global features that are extracted from the training image be identified even with some changes in image illumination, noise and scale. The extracted feature are mostly points and patches in the image [13].

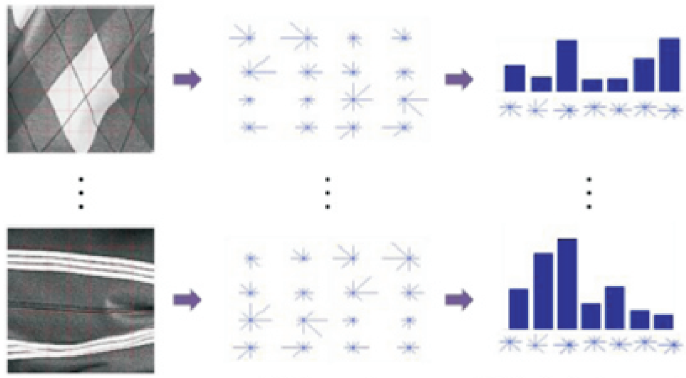


Fig. 6 Local image feature extraction using SIFT Descriptor.

In usual practice, detectors search local extrema in scale space to detect points of interest. Then these interest points are represented with respect to their support regions using descriptors. Here, to carry out sampling of interest points, the uniform grids are used. SIFT descriptors then represent the interest points which are evenly sampled. (see Fig.6)

D. Recurrence Quantification Analysis

Recurrence Quantification Analysis (RQA) can also be used for local feature extraction [2]. It upgrades the accuracy of SVM classifier. It uses following two features: Recurrence Plot and Recurrence Rate.

Recurrence plot is the graph that represents all the time when a state of the dynamical system has occurred. Recurrence rate is the percentage of points in recurrence plot.

E. Mathematical Morphology

Topological operations like histogram equalization, edge enhancing, sharpening, smoothening, binarization, filtering, erosion, dilation, etc. which extracts information for the geometrical representation can be performed using mathematical morphology approach [3] (see Fig. 7)

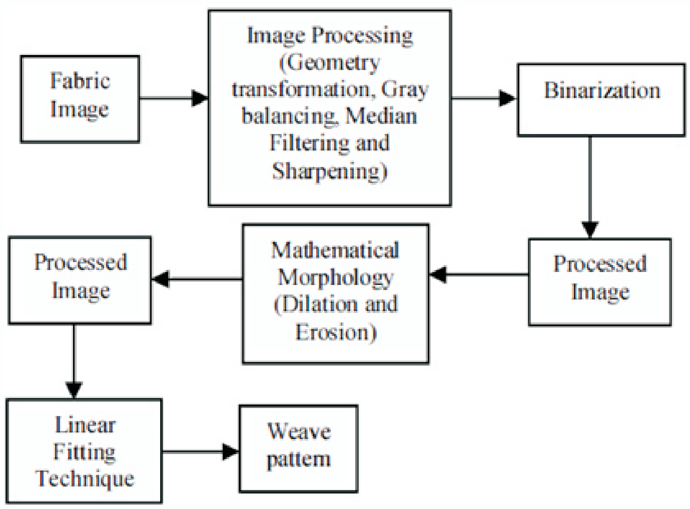


Fig. 7 Flowchart of Mathematical Morphology approach

The sub-images formed during this approach can give texture information. The interlaced points can be defined afterwards with the help of grey level differences along horizontal and vertical directions. Histogram of these points gives information as local feature.

F. Support Vector Machines

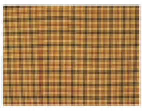
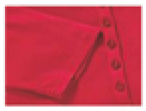
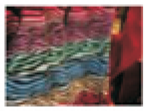
Support vector machine (SVM) is a classifier which can give results by combining local and global features extracted. A proper combination of multiple features may give better results than individual features. Even though in some cases, results can be disturbed as the combination might be noisy or contradictory.

IV.COLOR IDENTIFICATION

While considering color identification relationships between Hue, Saturation and Intensity plays an important role. By normalizing the histogram of each image in HSI color space, color is possible to identify. Pixels in the image for each image are quantized by the system into 11 different colors: white, gray, black, pink, purple, cyan, blue, orange, yellow, green and red. The dominant colors that is the one having pixels larger than 5% in the whole image will be used as output when two or more colors are there image.

Black, white and gray colors are easy to identify using saturation and intensity values. Let, S be saturation value, I be intensity value, ST be threshold saturation, IU and IL be upper and lower limits of intensity. Keeping S less than ST, if I is larger than IU then color is white; if I is less than IL then color black and for other values color is gray. For other than these three colors hue values are considered. This hue value H is considered to be measured on the scale of 0° to 360° color wheel. Following are the ranges covered: red $345^{\circ}-360^{\circ}$ and $0^{\circ}-9^{\circ}$, orange $10^{\circ}-37^{\circ}$, yellow $38^{\circ}-75^{\circ}$, green $76^{\circ}-160^{\circ}$, cyan $161^{\circ}-200^{\circ}$, blue $201^{\circ}-280^{\circ}$, purple $281^{\circ}-315^{\circ}$ and pink $316^{\circ}-344^{\circ}$.

TABLE I. SAMPLE IMAGES WITH PATTERN AND COLOR RESULTS

Image				
Pattern	plaid	striped	patternless	irregular
Color	yellow(49%) orange(36%) black(9%)	blue(75%) white(19%)	red(98%)	black(41%) red(26%) blue(6%) green(5%)

Color along with pattern gives more understandable information which actually can help visually impaired person. For example, instead of mentioning a cloth as striped only, it's better to mention stripes with blue and white colors. Table.1 shows such sample patterns and their results.

V. CONCLUSION

Here, an attempt for visually impaired people is made in order to make it easy to identify cloth patterns and colors. Texture analysis methods which were implemented in earlier attempts are not suitable as the cloth images have large intra class variations. Local and global features of images are extracted in order to recognize image pattern. RadonSig gives global directionality, STA gives global statistical data and descriptors like SIFT, RQA, mathematical morphology, etc. gives local features of the image. Detectors are used to identify area of interest in the image whereas descriptors extract features from that area. SVM combines multiple local and global features to give best possible pattern recognition output. Color identification is done by normalizing the histogram of image in HSI color space.

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