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An Implementation of Automatic Clothing Pattern and Color Recognition for Visually Impaired People

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***Abstract*—Daily chores might be a difficult task for visually impaired people. Automatic clothing pattern and color recognition can bring the independence in their lives. But, clothing pattern and color recognizing is a challenging problem due to illumination, rotation, scaling, and large intra-class pattern variations. We have designed a camera-based prototype system that identifies clothing patterns in four categories. They are patternless, plaid, irregular, and striped. This system can also identify 11 clothing colors. The system incorporates a camera, a microphone, a controller, and a Bluetooth earpiece for audio description for results. A camera is fixed on sunglasses is used to capture images. The clothing pattern and colors are spoken to users verbally. To determine clothing patterns, we propose a Radon Transform to determine the directionality of the image and to extract global features of the image from wavelet subbands. This feature is combined with local features to recognize complex clothing patterns.**

***Index Terms*—Automatic clothing pattern recognition, Color Identification, Extraction of global and local image features, texture analysis, visually impaired people**

I. INTRODUCTION

Based on statistics from the World Health Organization (WHO), there are more than 161 million visually impaired people around the world. Choosing clothes with suitable colors and patterns by themselves is a difficult task for them. They manage this task with the help from family members and friends. Automatically recognizing clothing patterns and colors system may improve their life quality. Automatic clothing pattern recognition is a challenging task due to large intraclass variations in the clothing patterns.

Existing texture analysis methods mainly focus on large changes in viewpoint, orientation, and scaling, but with less intraclass pattern and intensity variations. We have observed that traditional texture analysis methods cannot achieve the level of accuracy in the context of clothing pattern recognition. Thus here, we introduce a camera-based system to help visually impaired people to recognize clothing patterns and colors. This system contains three major components:
1) a camera for capturing clothing images, a microphone for input 2) clothing pattern recognition and color identification by using suitable software and 3) speaker for audio output to provide result of clothing patterns and colors to user.

Our system can handle clothes with complex pattern and color. It recognize clothing pattern in four categories. They are patternless, plaid, irregular, and striped (see Fig 1). It identifies 11 colors. They are yellow, blue, red, green, pink, orange, white, gray, cyan, black, and purple. For clothes with multiple colors, the dominant color is given as output.

In order to handle the large intraclass variations in the clothing pattern, we use Radon Signature, to capture the global directionality of clothing patterns. The Discrete Wavelet Transform is used to extract the Global Features from clothing image. The SIFT descriptor provides Local features of the Image. By providing these features to the classifier, it provides clothing pattern result to the user verbally.

Fig 1: Clothing pattern samples with large Intraclass pattern and color variations

II. PROPOSED SYSTEM

Our System involves 2 modules: Simulation part and Hardware Module. Simulation involves Processing the Image, Extracting the Image features and Classifying. Hardware involves process like capturing the Image and Providing the Result via speaker. The block diagram of our system is

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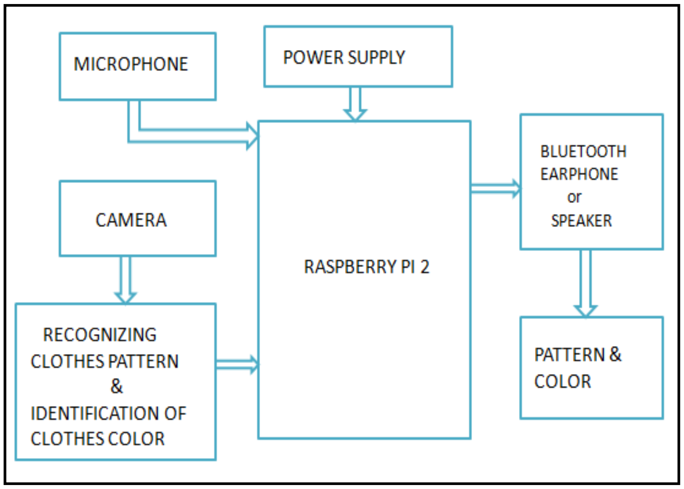


Fig 2: Overview and architecture design of the camera-based clothing pattern recognition system for visually impaired persons.

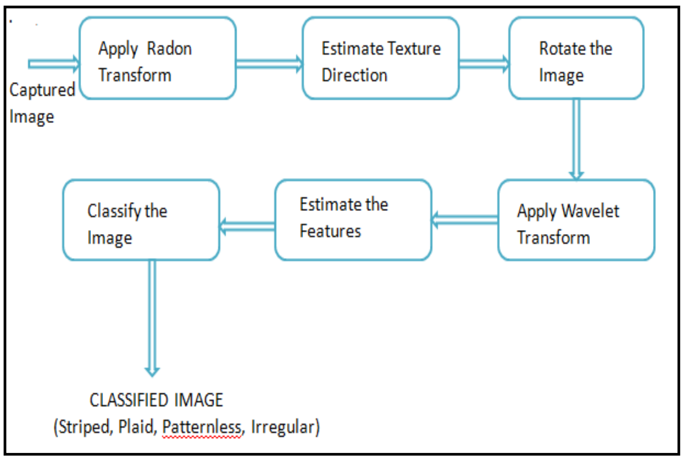


Fig 3: Pattern Recognition flow graph

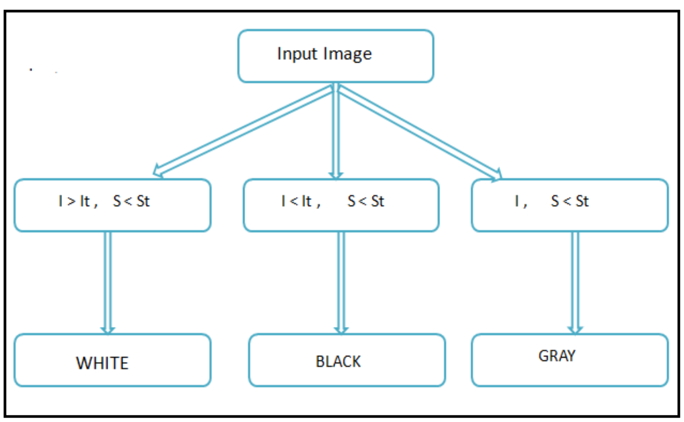


Fig 4: Color Identification using HSI Color Space for white, black and Gray

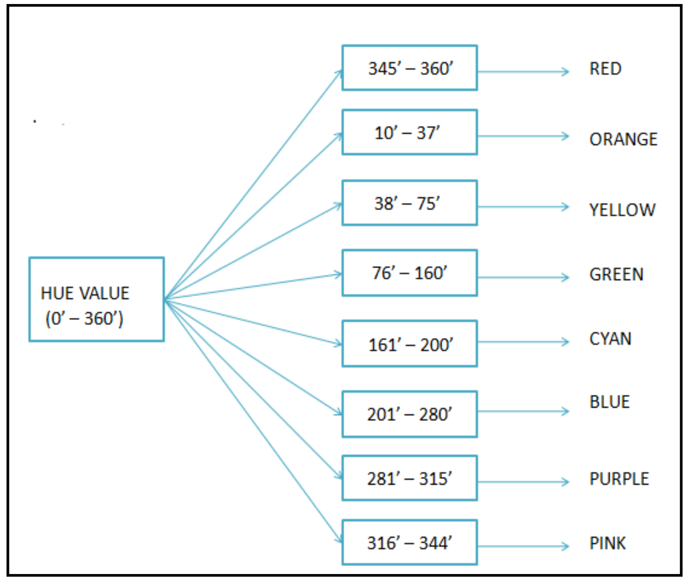


Fig 5: Color Identification by HSI Color space

In our system, image of the clothes is captured through camera. The captured image is processed through Radon Transform to find directionality of clothing pattern. Then wavelet transform is applied to extract the global and local features and it is given to classifier to get the result.

A. RADON SIGNATURE DESCRIPTOR

Clothing images has large intraclass variations, which is the major challenge for clothing pattern recognition. But, the directionality of clothing pattern is more consistent across different categories and it is important property to distinguish different clothing patterns. Due to the inherent properties of the Radon transform, it is a useful tool to capture the directional information of the image. The clothing patterns of plaid and striped are both anisotropic (properties of image will vary along the direction), while the clothing patterns of patternless and irregular are isotropic (at all the direction, it has same properties).

Radon transform is commonly used to detect the principle orientation of an image. The image is then rotated according to this dominant direction to achieve rotation invariance. The Radon transform of a 2-D function f (l,m) is defined as

$$R(a,\theta) = \int_{-\infty}^{\infty}\int_{-\infty}^{\infty} f(l,m)\,\delta(a - l\cos\theta - m\sin\theta)\; dl\, dm \text{ -- (1)}$$

Where a is the perpendicular distance of a projection line to the origin and θ is the angle of the projection line.

The Radon Signature is formed by the variances of r under all projection directions:

$$[\mathrm{Var}\,(r,\ \theta0\ ),\ \mathrm{Var}\,(r,\ \theta1\ ),\ .\ .\ .\ .\ ,\ \mathrm{Var}\,(r,\ \theta T-1\ )]$$

Where T is the number of projection directions. It determines the feature dimension of Radon Signature.

The general output from Radon Transform for all categories of clothing pattern is

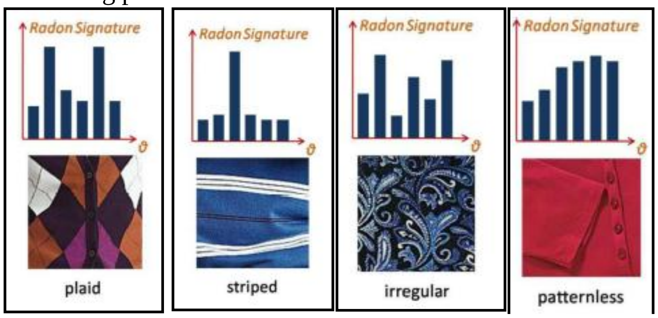


Fig. 6: Clothing patterns samples and associated Radon transform output.

B. FEATURE EXTRACTION USING WAVELET SUBBANDS (STA)

Wavelets are functions that are concentrated in time as well as in frequency around a certain point on image. It has ability to concentrate on non-stationary signals. The wavelet transform is designed in a way that we get good frequency resolution for low frequency components and high temporal resolution for high frequency components. The discrete wavelet transform decomposes an image into low-frequency channel and multiple high-frequency channels.

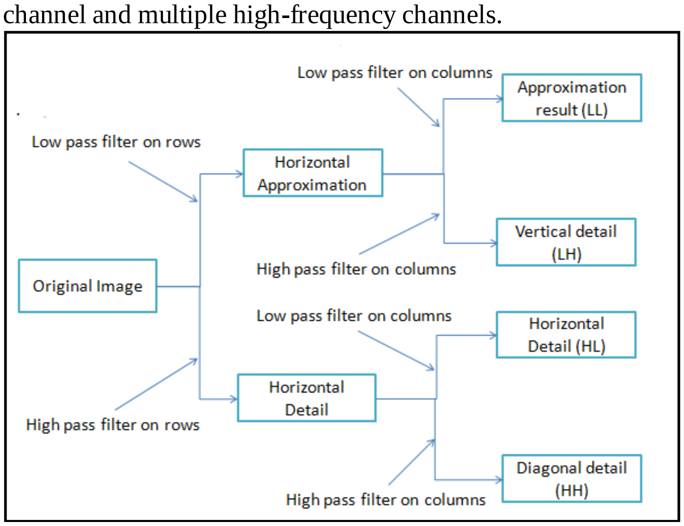


Fig 7: Process of extracting features from Image using Wavelet Transform

In this paper, we apply 3 scaling levels of transform to decompose each clothing image into subbands. For each subband, we compute single energy value. This energy value calculation for each subband includes four statistical values including variance, energy, uniformity, and entropy. By applying Wavelet Transform the image can be processed as:

HL1 - Horizontal details of Image at subband level 1
LH1 - Vertical details of Image at subband level 1
HH1 - Diagonal details of Image at subband level 1
LL1 - Approximation details of Image which is decomposed to level 2
HL2 - Horizontal details of Image at subband level 2
LH2 - Vertical details of Image at subband level 2
HH2 - Diagonal details of Image at subband level 2
LL2 - Approximation details of Image which is decomposed to level 3 to give above details at level 3.

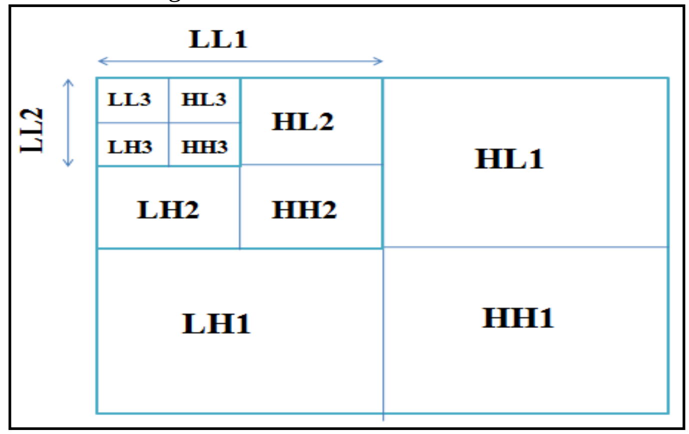


Fig 8: Wavelet Transform Output Sample

C. SIFT- (SCALE INVARIANT FEATURE TRANSFORM)

SIFT is used to extract the local features from the image. It has detectors and descriptor. The detectors will detect the interest points. The descriptors to compute the representations of interest points based on their associated support regions. Energy value is calculated for each and every pixel in an image and each pixel value is compared. The pixel which has different properties is represented as interest points. The remaining pixels are eliminated for processing.

III. RECOGNIZING CLOTHING PATTERN AND COLOR

The global and local features extracted from above mentioned method are combined to together for recognizing clothing patterns by using a multi class support vector machine (SVM) classifier.

The identification of clothing color is implemented by quantizing clothing color in the HSI (hue, saturation, and intensity) color space wheel. At the end, the result from both processes is provided in verbal manner through Bluetooth earphone to users.

A. RECOGNITION OF CLOTHING PATTERN

In recognizing the clothing pattern, the training set is selected as a fixed-size subset of each class. It consists of number of pattern images related to each class. Before identifying the pattern, the training set images is processed and its output is taken for comparing with the test set images. The global and local features obtained for test set image is used as input to the multi class SVM classifier. This classifier compares the test image features with that of training set and provides corresponding result.

B. IDENTIFYING CLOTHING COLOR

The color present in the clothing image is identified by HSI color space. The HSI color space (hue, saturation and intensity) attempts to produce a more intuitive representation of color. The I axis represents the brightness level in the pixel.

The Hue represents property of light in the pixel of the image by which it is classified in to various colors in reference with spectrum. H is the angle, which specifies the range for each colors such as red is at zero, green at 120 degrees, and blue at 240 degrees. In particular, for each clothing image, our color identification method quantizes the pixels in the image to the following 11 colors. They are black, gray, white, orange, yellow, green, cyan, blue, purple, pink and red.

The detection of colors of black, white and gray is based on the saturation value S and intensity value I. If the intensity I is less than a intensity threshold I_t and saturation S is less than S_t, then the color of a pixel is determined to be black. If the intensity I of a pixel is larger than a upper intensity threshold I_t, and the saturation S is less than a saturation threshold S_t, the color of the pixel is white. For the remaining values of I while S is less than S_t, the color of a pixel is identified as gray.

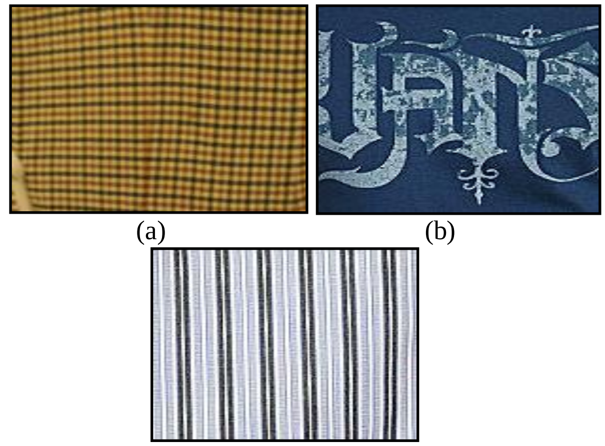
For other colors, the hue values are used. The hue can be visualized as a 360° color wheel. This wheel is divided into small range for each color. We represent the color of orange in the range of 10° to 37°, yellow in the range of 38° to 75°, green in the range of 76° to 160°, cyan in the range of 161° to 200°, blue in the range of 201° to 280°, purple in the range of 281° to 315°, pink in the range of 316° to 344° and finally red as 345° to 360°. If the testing cloth image consists of multiple colors, the majority color present in image is given as output to the user.

IV. RASPBERRY PI 2 USED IN THE HARWARE

The Raspberry pi 2 is a series of credit card sized single-board computers. Raspberry Pi 2 model b is the second generation of the Raspberry Pi. It includes features like, it has a 900MHz Quad core ARM Cortex-A7 CPU. It supports 1GB RAM of memory. It has 4 USB ports through which external devices can be connected. It has 40 GPIO pins for input and output processing. It supports Full HDMI port through which multimedia data can be transferred. It has Camera Interface (CSI) through which camera can be connected for capturing images. It also has Display Interface (DSI) for displaying processed output. It provides Ethernet port for communicating with other device via internet and also it has Micro SD Card slot. The power requirements for the Raspberry Pi 2 increases if we utilize more interfaces.

The Micro phone is connected to Raspberry Pi so that blind user can verbally request the function they want the clothing recognition process to perform on the captured image by camera interfaced. After processing the results will be presented to the user as audio output like found or not found. If user desired is found, then it process for the color output. If it is not found, it request for another input.

V. SIMULATION RESULTS AND DISCUSSIONS



(a) (b)

(c)

Fig 9: Input Images of the clothes

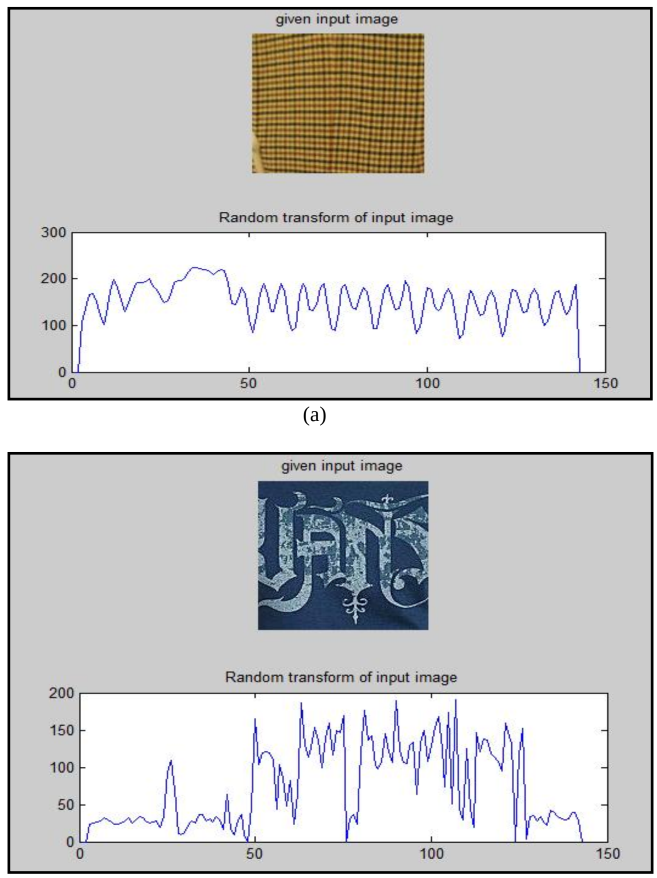


Fig 10: Radon Transform output for the given input image (a) & (b)

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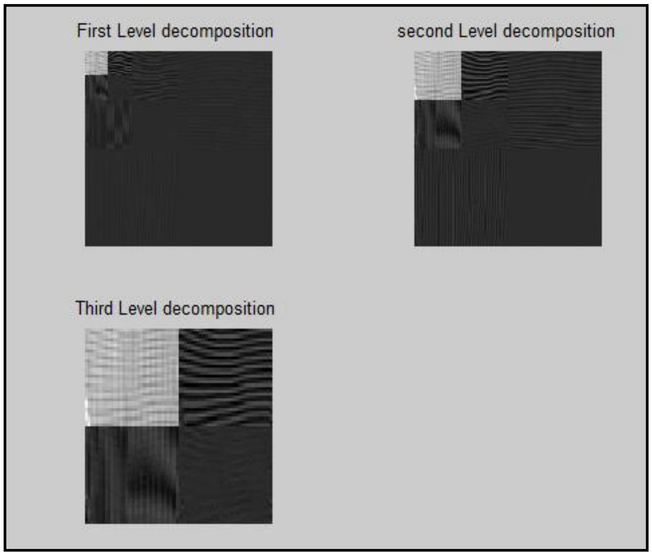

Fig 11: Output from the Wavelet transform for the image (a)

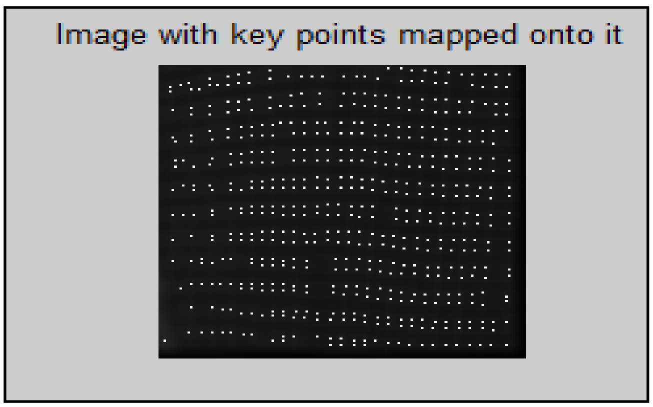

Fig 12: Extraction of key points using SIFT for the input image (a)

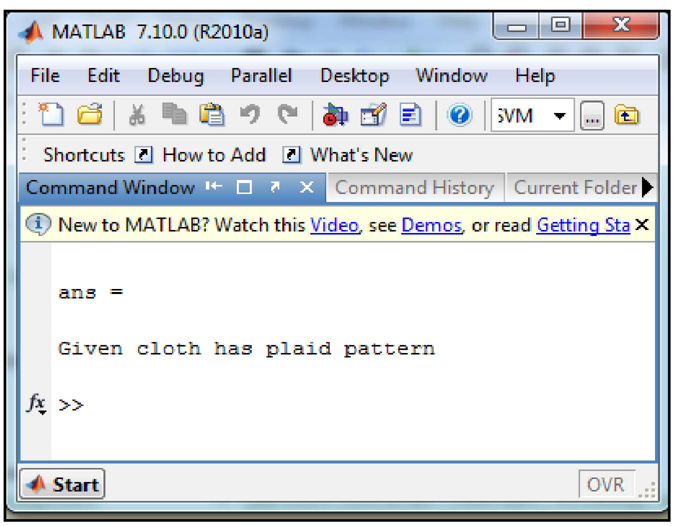

Fig 13: Output of the Pattern Recognition for the input image (a)

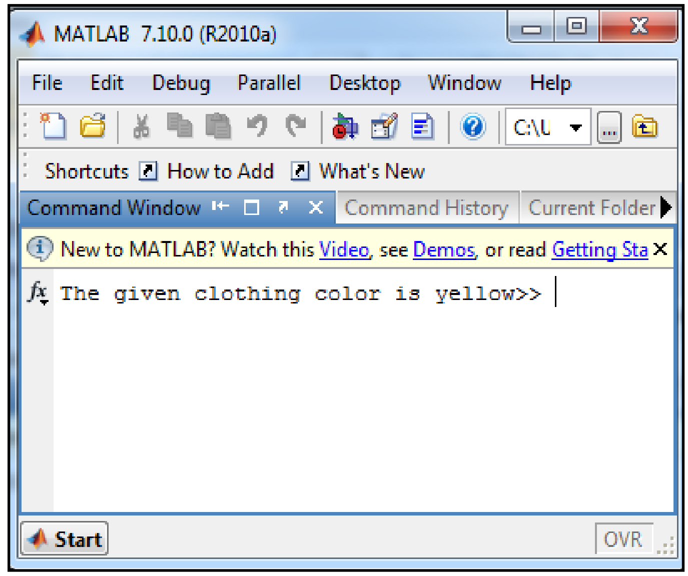

Fig 14: Output for Color Identification for the input image (a)

VI. CONCULSION

Thus we designed a system to help the visually impaired people for identifying suitable clothes using pattern recognition and color identification method and it improves their quality of lives. The Radon Transform gives directionality of image, then STA and SIFT extracts the global and local features of the image which is all combined together and given to classifier for getting result. Classifier uses the data set of clothing pattern for determining the result. The HSI color space is used to identify the color of the clothing image by analyzing pixels in the image in terms of Intensity, Saturation and Hue. This system enriches the study of texture analysis. Future work will include a comparison with a laboratory experiments in order to compare simulation and experimental results.

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BIOGRAPHIES

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