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Colour and Pattern Recognition for Visually Impaired People with Kinect Sensor

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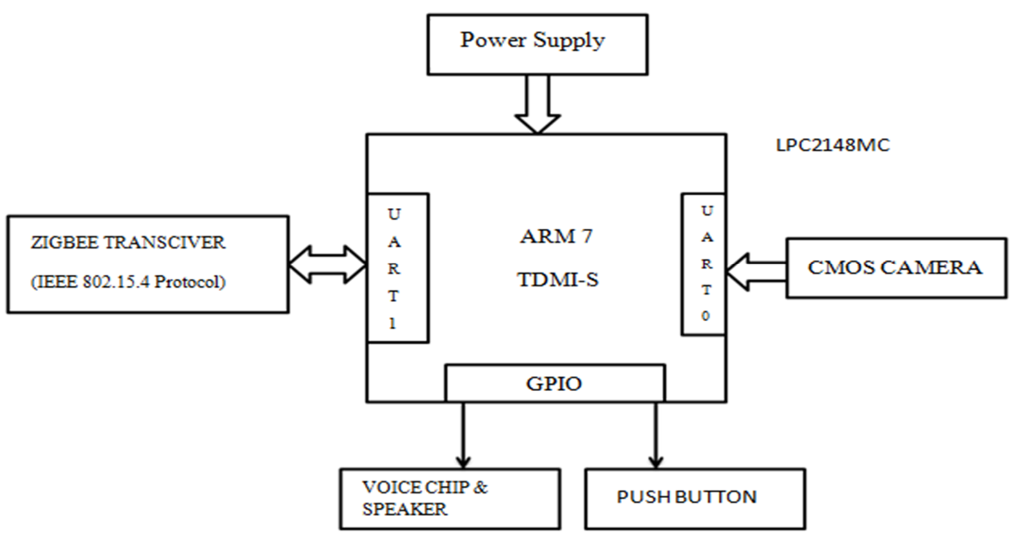
Abstract-Development of a sensing gadget that can provide sufficient perpetual substrate for persons with visual impairments to orient themselves and recognize patterns has been a persistent rehabilitation technology goal, with the blind user interface posing a significant challenge. In this project we present an advanced cloths pattern and their color recognition technique by using CMOS camera and zigbee interfaced to ARM based device through which we can transmit cloth image wirelessly to a remote server. The cloth pattern analysis is done on server PC through MATLAB simulation, the result of which is sent to the blind gadget wirelessly through zigbee. This information is fed to blind person through voice output with voice chip and speaker connected to the gadget.
Keywords: CMOS camera, Zigbee, ARM

I. INTRODUCTION

In everyday life, people need to find appropriate clothes to wear. This is a very challenging task for blind people to choose clothes with suitable colour and pattern. Although many methods have been developed for texture matching and colour detection in the computer vision and image processing research, currently there is no device that can effectively supply matching choices for blind people. In this paper, we develop a computer vision-based prototype to match a pair of images of two clothes for both pattern and colour. The image pair is captured by a camera which is connected to a computer. Results of the matching algorithm are reported via text-to-speech outputs. To configure and control the system, users can simply speak out the commands to switch on/off the system, execute corresponding functions, and adjust the volume of audio outputs. Our algorithm can detect: 1) colours of the clothes; 2) whether the clothes have pattern or have homogeneous colour3) whether the colours match for a pair of images; and 4) whether the patterns match for a pair of images.

Block diagram:



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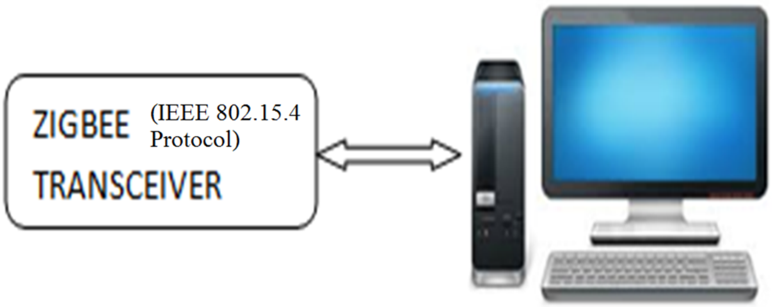

II. METHODOLOGY FOR CLOTHES MATCHING

There are three main components in our methodology for clothes matching: 1) color detection and matching, 2) pattern detection, and 3) pattern matching.

A. Color detection and matching

Our colour detection is based on acquiring a normalized colour histogram for each image of the clothes in bi-conic (hue, saturation, luminance) HSI colour space. The key idea is to intelligently quantize colour space based on the relationships between hue, saturation and luminance. In our colour classification, we first detect colours of "white", "black", and "gray" based on saturation *S* and luminance *I*. If the luminance *I* of a pixel is large enough, and saturation *S* is less than a special threshold, then we define the colour of the pixel as "white". Similarly, the colour of a pixel "black", can be determined if the luminance *I* of a pixel is less enough and saturation *S* is also satisfied with the condition. Under the rest values of the luminance *I*, pixel of colour "gray" could be found in a defined small S radius range. For other colours (e.g. red, orange, yellow, green, cyan, blue, purple, and pink**),** hue information is employed. The dominant colours will be communicated in auditory to the blind user. If there is only one dominant colour, which means the clothes has uniform colour without patterns. If both images from the image pair have uniform colours, then no further pattern matching processing is needed because we can easily know the clothes pair is match or not only based on the colour detection and matching. However, for clothes with multiple dominant colours, the user will not be able to figure out whether the white and blue colours are mixed together only based on the colours classification results.

(a) An example with patterns and mixture colours (74.5% blue, 18.7% white, 3.5% black, 1.7% gray) (b) An example without pattern and mixture colours (5% blue, 94% white).
To detect the colours of a pair of clothes image, the dominant colours are compared. If the categories and the order of the first 3 dominant colours are same, the colour of the pair of clothes is match.

A. Clothing Patten Detection

Our method for detecting if an image of clothes has patterns is illustrated in Based on the colour detection results from previous section, if there is only one dominant colour, the input image of clothes has no pattern. Only for the images with multiple dominant colours, we continue to check if the multiple colours are caused by patterns. To detect if an image has patterns or not, we first transfer it to gray scale image, and then perform Gaussian smoothing to reduce noise. Next Canny edge detection is applied to detect the edges (i.e. pixels has intensity discontinuities) in the image followed by a morphology processing to remove the edge pixels with small areas. At each edge pixel, we check the neighbour pixels around it by using a 3×3 mask to get the directions of the edge. Along the edge direction, we calculate the colour values on the both sides of the neighbour's position in the original image. If the colours from both sides are different, the edge is more likely caused by pattern. Otherwise, the edge pixel is removed from further processing. Finally, we calculate the total edge ratio with the image having pattern if the edge ratio is larger than a threshold (given by a parameter). several successful examples to handle edge noises caused by folders, sleeves, and wrinkles of clothing for pattern detection. If both images from the image pair are without patterns, we treat them as a "pattern match". For images with patterns, we will continue to perform pattern matching.

B. Clothing pattern matching

Texture analysis and classification has been widely used for applications of image retrieval and industry inspection. For pattern matching for clothes, the following main factors have to be addressed: 1) rotation invariance. The method should be able to analyze the patterns when the clothes images are in arbitrary orientations. 2) Insensitivity to lighting changes; and 3) the method should be simple enough so that to be transferred to devices having less computational power. Wavelet transform provides spatial and frequency information which can be used to analyze texture features. But wavelet transform is sensitive to the orientation variant. Making texture rotation-invariant becomes the key point before wavelet transform. we develop a new texture pattern analysis approach which is robust to variations of rotation and illumination in the system. In application of clothes matching, we found that illumination changes significantly affect the matching results during the experiments. For an input image pair of clothes, to decrease the effects of illumination changes and be prepared for further processing, image pre-processing is first performed on each image. The pre-processing step includes conversion colour image to grey, histogram equalization, and selection of a circle region centred of the image (which contains main information of the clothes). Then, we chose Radon transform to obtain the dominant orientation information of the image patterns and rotate it back to 0 degree to make the algorithm rotation invariant. Next, we employ a Haar wavelet transform to extract features on 3 directions (horizontal, vertical, and diagonal) and calculate co-occurrence matrix for each wavelet sub images. The Haar wavelet is a certain sequence of rescaled “square-shaped” functions which together form a wavelet family or basis. Finally, the matching of clothes patterns is performed based on six statistical features which are commonly used for texture analysis. Compare to existing methods, our method is robust to match clothes with complex texture patterns, as well as to handle clothes with large lighting changes.

C. Radon Transform for Pattern Orientation Estimation And Normalization

In order to make our algorithm invariant to pattern orientations, we apply Radon transform on the maximum circle region which is centered in the input image $f(x, y)$ for a given set of angles to estimate the dominant orientation of the patterns. Radon transform can be thought of as computing the projection of the image along the given angles which varies from 0° to 180°. In our system, we choose a region with circle shape since it has the least direction interference comparing with other shapes. For each given direction, the radon transform can be thought of as computing the projection of the image along the given direction. where $\rho = x\cos\theta + y\sin\theta$ is the perpendicular distance of a line from the original position and is the angle between the line and y-axis.

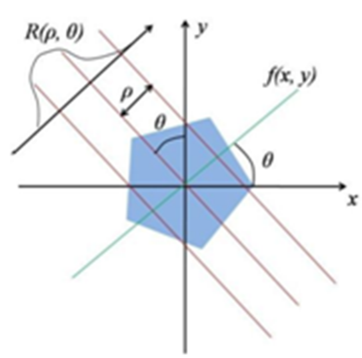

Fig: Radon Transform

The resulting projection is the sum of the intensities of the pixels in each direction. The radon transform computes projections along θ, which varies from 0° to 180° in discrete steps of Δθ. So for any Δθ, the texture pattern principal orientation can be estimated as the projection which has the straightest lines. We determine the final dominant orientation by calculating the mean of the variance of projections at 6 neighbour angles around each local maxima variance if there are two or more principal orientations. The orientation

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with largest mean value will be chosen as the final dominant orientation of the texture pattern.

D. *Wavelet Feature Extraction*

Wavelet transform is a local transformation of space and frequency which can effectively extract information from the images for texture analysis. The wavelet series expansion of function can be defined with respect to a scaling function and a wavelet function with different scaling and wavelet coefficients. With the coefficients we can easily obtain the different levels of wavelet decomposition. In our system, we use two levels of decomposition. an instance of Haar wavelet transform resulted on three directions (horizontal, vertical and diagonal) of the image.

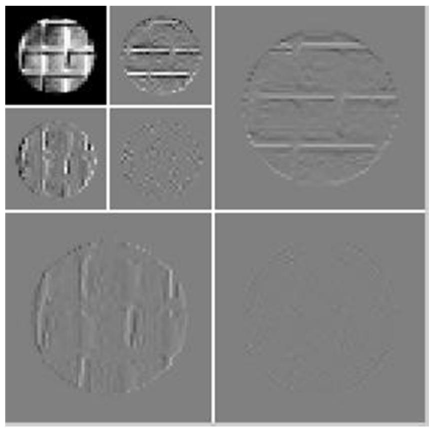


Fig: Harr wavelet

E. *Pattern Matching*

To match patterns, we compose statistical features such as mean, variance, smoothness, energy, homogeneity, entropy from different order moments of the co-occurrence matrices. A distance function is defined from the about six statistical features between the input image pair to determine if the pair of images matches.

$$Mean = \sum_{i,j=1}^{L} (i) f(i,j)$$

$$Variance = \sum_{i,j=1}^{L} (i - m)^2 f(i,j)$$

$$Smoothness = \sum_{i,j=1}^{L} (i - j)^2 f(i,j)$$

$$Energy = \sum_{i,j=1}^{L} f(i,j)^2$$

$$Homogeneity = \sum^{L} \frac{f(i,j)}{\quad}$$

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

$$Entropy = -\sum_{i,j=1}^{L} f(i,j)\log_2 f(i,j)$$

where *f (i, j)* is the *ij*th term of co-occurrence matrix *G* divided by the sum of the elements of *G*. *L* is the number of distinct intensity levels, *m* indicates the first feature mean.

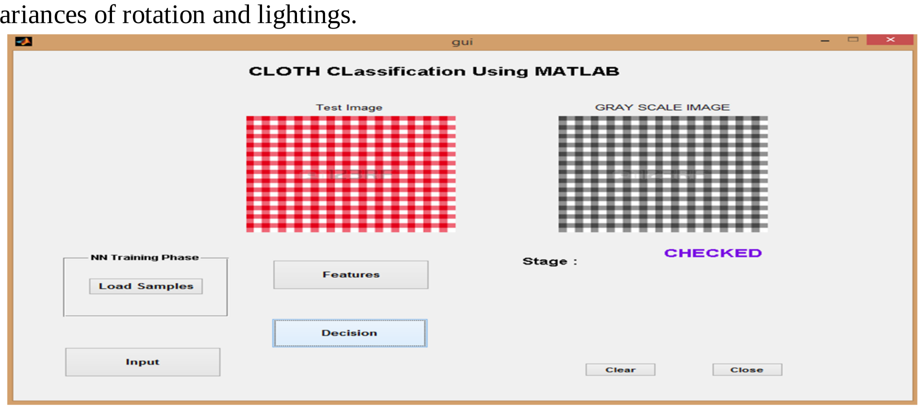
III. RESULTS AND DISCUSSIONS

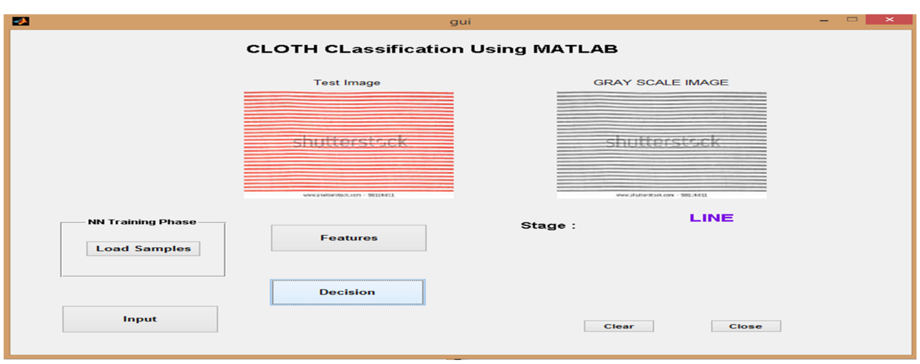
A. Databases

The robustness and effectiveness of the proposed method are evaluated on two datasets of clothes we collected: 1) colour and matching (CTM) dataset; 2) pattern detection (TD) dataset. The CTM dataset is collected for pattern and colour matching, which contains images of clothes with complex patterns, multiple colours, and lighting changes of them some have their match pattern pairs and some don't have not match pattern pairs. The TD dataset is collected for pattern detection, which contains clothes images with or without patterns and in uniform colour or multiple colours.

B. Clothes matching results

In our test, we evaluated the proposed method for pattern detection (i.e. to determine if the clothing image has patterns or not), colour matching, and pattern matching. The testing results are summarized. For pattern detection, we use all the images in TD dataset. Among the TD dataset, the rate of pattern detection is 100%. For pattern matching, we select 50 matching pairs and 83 non-matching pairs from CTM dataset. Our method achieves 85% accuracy rate and is robust to clothes with complex texture patterns, multiple colours, and variances of rotation and lightings.





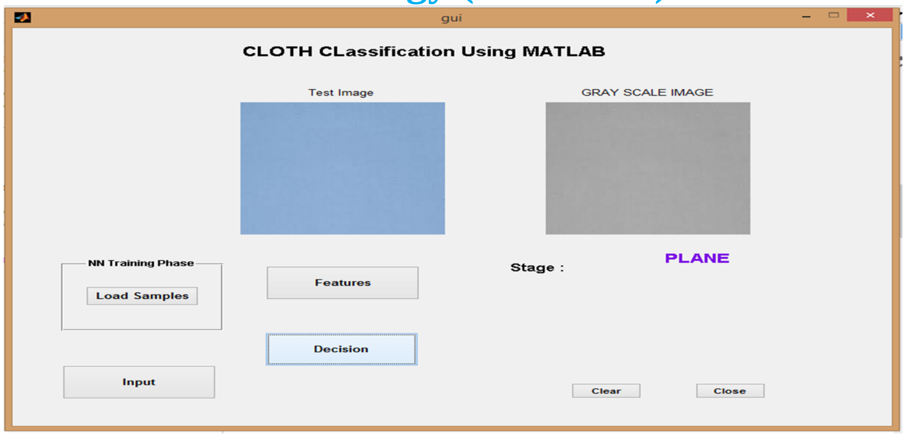


Fig: Examples of pattern matching

IV. CONCLUSION

We have presented an approach to matching clothes with complex patterns for blind or visually impaired people. The approach combines Radon transform, wavelet features, and co-occurrence matrix for texture analysis. Our approach significantly outperforms existing methods on our dataset containing images of clothes with complex patterns and lighting changes. The detection results demonstrated that our method is robust and effective to handle rotation and illumination changes. The matching results are displayed as speech outputs to help blind/visually impaired users. Our future work will focus on transferring the function to cell phones. We will also address the human interface issues for image capture and auditory display of the clothes matching.

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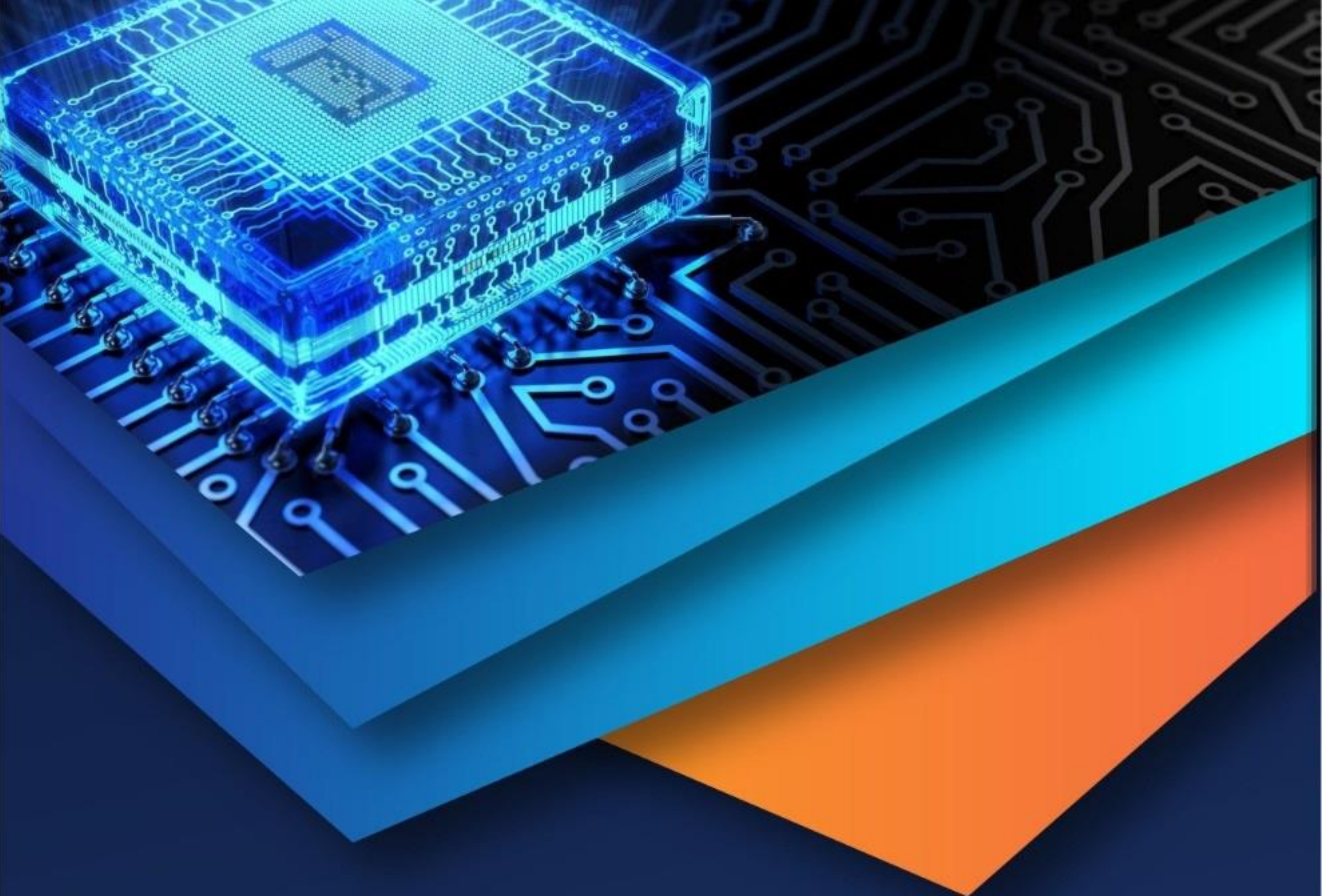

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