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An Autonomous System of Pattern and Colour Identification for the Visually Impaired

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ABSTRACT

A visually impaired person can identify the shape of an object by the sense of touch but to recognize the colour and pattern of a textile would require the assistance of a helper. The paper proposes a system which can assist a person with visual disability in real time. The proposed system will be able to detect both the colour as well as pattern of the textile. For pattern detection, Hough line transform is implemented and for colour detection k-means clustering algorithm is implemented. Both used together can detect the colour and pattern, thus making the user independent of assistance of another. The system can detect patterns such as plain, vertical stripes, horizontal stripes, diagonal pattern and checks. Also the system detects the entire range of colours and the colour range is not limited. The main scope is to build an independent system which will be self-sufficient. The system also converts the identified data to audio for assistance to the visually impaired.

Key words: Image processing, Hough Line Transform, k-means Clustering Algorithm

1. INTRODUCTION

Technology is to assist humans to perform better and to support where assistance is required. The paper proposes to build a system that is autonomous and real time which will assist the visually impaired to recognize the colours and patterns of a textile. A number of papers have been developed for image processing in surface matching and colour identification [1][2][3]. For pattern matching, databases are formed and wavelet transforms applied to extract its properties [4][5].

In this paper a system is proposed which is real time and portable. Portability been an issue to be tackled, Raspberry Pi was utilised to implement pattern and colour identification. The camera used is the Raspberry PiCamera which connects directly to the camera interface on the board. The overall size of the system is minimised.

The system includes a camera, a processor board for processing the video and image and an audio output device for converting the identified data to speech. It uses a camera to take visual data; the Raspberry pi board receives the data through the camera interface port. For the purpose of image processing, Open Computer Vision (Open CV) module is utilized. For converting the data to speech, espeak module is applied. The Raspberry Pi was run on Raspbian OS. Raspberry Pi was chosen because of its wide availability, small form factor and vast developer base. The entire process was implemented in python.

2. PATTERN DETECTION

For pattern matching Hough Line transform [6] is implemented. A line can be described by the equation $y = mx + b$. The equation cannot be used to describe vertical lines. Thus Hough transform depends on the polar co-ordinate system. An edge detected pre-processed image is applied to the Hough transform. Figure 1 shows the Hough line transform is used to extract the lines in an image. The

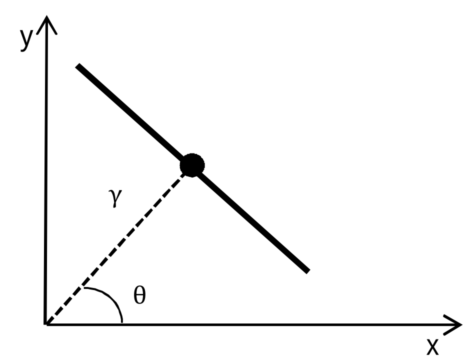

Figure 1.The Hough line transform used to extract the lines in an image.

parameters returned are (θ,γ). θ represents the angle between the x-axis and the line joining the origin with that neighboring point and γ represents the length from the origin to the nearest neighboring point on the straight line.

In Hough line transform, each point or edge is considered separately. For a single point, imaginary lines are drawn and these lines are represented as points on the polar co-ordinates space. The plot of the equivalent points in the polar co-ordinate space form a sinusoidal curve. The process is repeated for every point detected during the pre-processing edge detection stage. All the curves once plotted on the polar co-ordinate space, will cross few particular common points. The point with the most curve crossings in the polar co-ordinate space indicates a line the Cartesian co-ordinate space.

Hough line transform detects image which are broken as well as distorted. This characteristic becomes an advantage when the camera captures images of textile that are wrinkled, applying the edge detection will show not perfect lines but lines that can be broken or distorted because of the wrinkles. The two parameters returned by the Hough transform are (θ,γ). γ is the perpendicular distance form (0,0) to the line been considered and θ is angle formed between the perpendicular line starting from (0,0) and the horizontal axis. θ is measured in the counter clockwise direction.

Consider the line which is positioned below the origin, the line will have values in the polar co-ordinates of positive γ and θ less than 180^0. γ value will be negative and θ is measured less than 180^0, when the line passes above the origin. Thus for vertical and horizontal lines θ will be 0^0 and 90^0 respectively. The transform returns a two dimensional array. The first array is the quantised θ and the second array is the quantised γ. For each γ and θ, each incident of a point or pixel in the original image that is close to the line under consideration, the particular array is incremented. The element which has the highest value in the array indicates a straight line in the original image. By varying the threshold of the edge detection, the number of lines detected will vary accordingly.

For pattern detection, the camera is initialised and from the video , a frame is taken for the purpose of analysis. The image under consideration is first blurred, to reduce the number of edges detected. The camera used in this was a 5 megapixel resolution, if the image is directly processed using Hough transform then apart from the pattern even wrinkles, and other fabric texture will also be accounted for. Thus the image is first blurred. For the purpose of pattern matching, colour data is not required, thus the colour image is converted to a grey scale image. This the overall size of the image reduces by a third of the original size. The blurred and grey scale image is then canny edge detected, to identify the edges in the processed image. Next, Hough line transform is applied to the edge detected image. The transforms produces a matrix of (θ,γ) . Depending on the number of lines, the image is classified as plain, diagonal, vertical stripes, horizontal stripes or checked pattern. If the Hough transform does not return any lines (the matrix is empty)then the pattern is plain. If the image contains more lines with theta less than 10^0 , then the pattern is classified as horizontal pattern and if the transform returns that there a more lines greater than 80^0, then it is classified as vertical pattern. If there are more lines which have θ between 0^0 and 80^0 then the image is classified as diagonal. Similarly, if there an equal number of both vertical and horizontal lines, then the image is classified as checked pattern. The identified pattern is send to the espeak module to convert the date to text.

3. COLOUR RECOGNITION

For the purpose of colour identification, k-means clustering algorithm [7] is implemented. The algorithm is unsupervised machine learning algorithm which is implemented when the data set is unlabelled. The groups in the k-means algorithm are not allocated before processing only the number of centroids is specified. The labelling happens organically through an iterative process. The algorithm is commonly implemented for sorting measurement data, detecting irregularities, behavioural and inventory categorization. Rather than identify a single major colour in the entire image, the algorithm helps in partitioning into a specific group of clusters. In any image depending on the RGB values, there can be infinite number of combinations of colours. Thus k means clustering algorithm assists in segregating into k number of major clusters. For an image, each pixel is considered a data point. Each data point is assigned or labelled to the cluster having the closest mean. Each pixel has a Red, Green and Blue value. Using the RGB value, the mean is calculated and the particular pixel is labelled to specific cluster with the nearest mean (colour). Thus a requirement of k means clustering algorithm is to specify k, the number of clusters before processing.

Due to the innumerable colours that can be defined by various values of RGB, colour quantization is required. Colour quantization reduces the number of colour in the image under consideration. For the purpose of colour quantization, k-means clustering algorithm is utilised since it important to reduce the number of identified colours. When an image is taken using a camera, each pixel defines a colour because of the value of RGB pixel value. Thus k-means clustering algorithm groups the entire image colour groups by the value specified in k.

For colour identification, a frame is captured using the PiCamera, the capture image is reduced in size to reduces the number of points or pixels required for colour identification. More the pixels, the processing time will also increase accordingly. The reshaped image is applied to k-means clustering algorithm. Depending on the value of k, the points will be grouped accordingly. The algorithm will return the

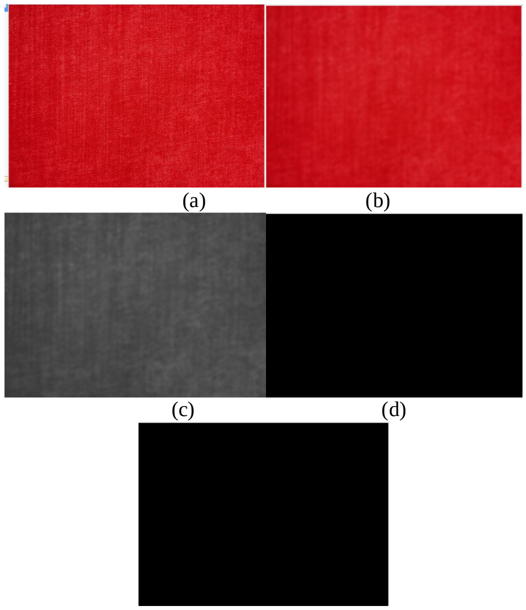

Figure 2. (a) A red plain textile image is set as the input (b) blurred image (c) grey scale image (d) edge detected image (e) output of Hough line

RGB value of the clusters. The RGB value is converted to English colour names with the help of webcolours module. Also the module helps to define the range to a fixed known range of colour set. The data produced form the module is passed onto the espeak module to convert the identified data to speech.

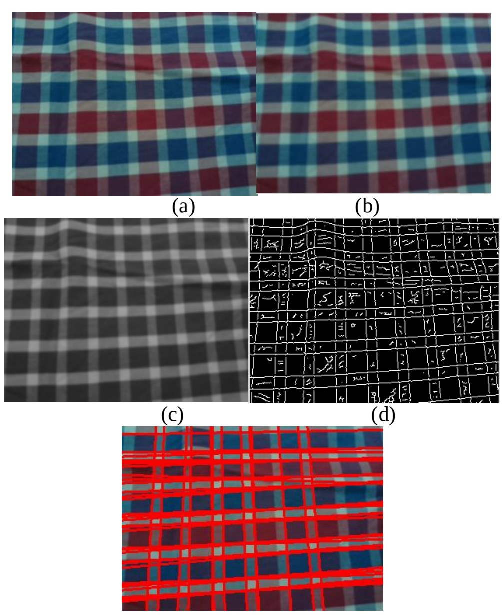

Figure 3 (a) A check red blue white textile image is set as the input (b) blurred image (c) grey scale image (d) edge detected image (e) output of Hough line transform.

4. Results

The system was tested with both images loaded from memory and images from the camera. The images processed

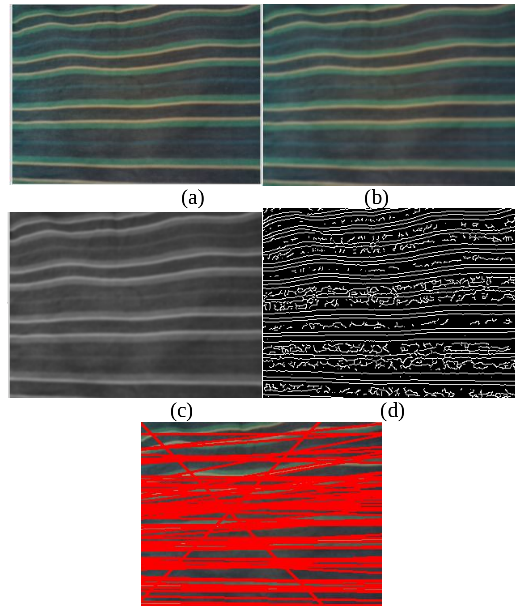

Figure 4.(a) A horizontal stripes with blue and green textile image is set as the input (b) blurred image (c) grey scale image (d) edge detected image (e) output of Hough line transform.

using the camera is subject to lightning conditions, orientation of the textile and wrinkles in the textile. Figure 2 shows images of proper clarity, the colours and pattern were detected properly. For plain red textile the colours detected were crimson and firebrick for k=2. Figure 3 shows a textile with checked pattern. The Hough line transform produces an almost equal number of vertical and horizontal lines. Therefore, the pattern is detected as checked pattern. Figure 4 shows for textiles with mild wrinkles, the system was able to properly process the images and the wrinkles can be considered as lines during edge detection.For the horizontal blue and green textile image, the lighting conditions were low and the colour recognised by the k-means clustering algorithm was blue, dark slate grey and dim grey for k=3. Furthermore, textiles image which was completely wrinkled, the system failed to identify the pattern. Therefore, the pre-conditions was to ensure the textiles under consideration were without wrinkles. And the lightning condition and camera capability also made important parameters for the accuracy of the result

5. Conclusion

The systems identified the textiles images with mild wrinkles accurately. Apart from the mentioned patterns, any other pattern was not detected. For future work of detecting circular shapes and other similar patterns, Hough circle transform has to be applied.

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