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A Fast Reading and Processing Method of Obstacle Detection in Changing Environment Using Color and Texture

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Abstract: ***A leading obstacle detection algorithm based on color and texture feature used monocular vision is basically described in this paper. The purpose of this paper is to provide an eye to a visually impaired people so that he is able to safely navigate in a surrounding environment of the campus. Color and texture feature is used to implement the algorithm. Color information is easily available and computationally cheap to process the image. Color of surface changes dramatically when the illumination condition changes so in many cases, color information alone is not sufficient to detect an obstacle in the path of visually impaired people. To safely navigate in campus texture feature is used with color feature. A set of 100 sample images is collected from the College campus. Our algorithm learns a set of color and texture feature from a set of sample images and the only most effective features are used in classification. As our algorithm works in challenging outdoor environment it achieves better performance and efficiency to locate an obstacle and to navigate safely in campus.***

Keywords—: **Color, local edge pattern (LEP), training set, histogram, obstacle detection**

1. INTRODUCTION

Obstacle detection is an important issue in the world wide area of an autonomous navigation system. As technology is increasing day by day mobile robot are widely used to interact with people. So for visually impaired people and for autonomous land vehicle

system needs to detect and locate any obstacle in surrounding environment to operate safely. For this purpose, visual sensing device are often used. To implement the algorithm described in this paper we used monocular vision system in which a single camera is mounted on the head of mobile robot. Objective of this visual system is to detect obstacle and recognize safe traversable path for the blind people. Most method used only color feature [1,2] rather than combined feature of color and texture [3,4,5]. System to detect an obstacle in path consists of two parts: a learning algorithm and a classifier. Learning algorithm learns set of color and texture feature from a set of 100 sample images taken from campus. The classifier then compares the new image taken from camera mounted on head of mobile robot from the learned model and decides if there is an obstacle in a path.

Two kinds of texture descriptor (color histogram and LEP) are adopted here. The former is related to the distribution of colors in a region, while the latter, to the distribution of local edge patterns in a region. Color is important aspect to extract information from regions. So color histograms are commonly used to detect an obstacle in the region. However color information is easily available from colored camera for path recognition [6]-[7], it has several shortcomings. First color illumination condition changes according to weather i.e. color constancy problem [8].Second path and obstacle may have similar color. The LEP originates with texture descriptor LBP [9]. LBP contains the local intensity pattern of pixels and its

histogram are used when color histogram are not suitable to detect an obstacle in a path.

In this paper an algorithm is proposed for safely navigation of autonomous mobile robot. When the blind person reaches very close to obstacle the algorithm plays a long beep to recognize that obstacle. Training set of images and classifier are used to model the path as traversable. During training, instead learning color and texture feature for separate classifier, the color and texture feature are learned for all set of images to improve the performance of algorithm. These features are learned using histogram method.

In section 2 we describe the basic concept of color and texture feature. Section 3 describes the proposed algorithm for obstacle detection in the traversable path. Experimental tests and its evaluation are reported in section 4. Section 5 summarizes the paper.

2. BASIC CONCEPT OF COLOR AND TEXTURE FEATURE

Two types of texture descriptor color and LEP histogram are adopted here. These are used to learn the colour and texture feature from set of samples images taken from campus.

A. Color feature:

Color is most popular choice for image retrieval and for obstacle detection. Color of a pixel is represented in Red (R), Green (G), Blue (B) color space or Hue, Saturation, Value (HSV). Color histogram is based on the intensity of three colors Red, Green, Blue (RGB). Each of RGB band is divided into four bins covering the range of 0-255. The Red band is divided into four part 0-64, 64-128, 128-192, and 192-255. Green and Blue band is divided in same range, resulting in a color histogram of 64 bins. Color histogram H_c of region of image is computed using the following equation:

$$H_c = n_i / N \quad i=1,2,3.....64 \qquad (1)$$

Where n_i is number of pixel fall in region defined by bin i and N is total number of pixel in region. Now color feature are learned of all training image set using color histogram and then new images are compared with learned model to traverse the path correctly.

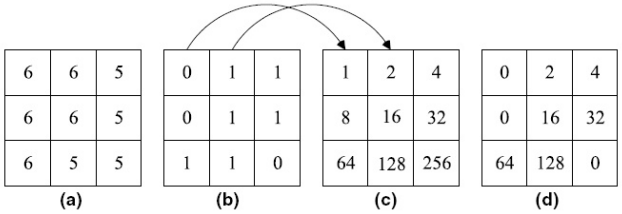
For histogram comparison of new images with training set of images simple intersection method of two color histogram is used. There are many methods to compute the comparison of two images like chi square test, Statistical test but intersection method is used in this paper as in this method no complex operation used only addition and subtraction is used. The intersection method computes the sum of common area between two histogram as in the following equation:

$$\text{Sum} = \sum_{k=1}^{n} \min (S_k, M_k) \qquad (2)$$

Here n is total number of bins in image to compute color histogram that is 64. S and M are used for sample and model histogram where S_k and M_k show the value of bin k in S and M. The greater common value between these two histogram is considered as path as traversable means there is no obstacle in path.

B. Texture feature:

The texture feature LEP originates with texture descriptor LBP[4]. LBP describes the intensity of each pixel in the region and its value is computed by 3×3 matrix figure1 (a), in this matrix central pixel is treated as threshold value, if entry in the 3×3 matrix is greater than threshold value than it will be counted as 1 Figure1 (b) and it is multiplied by corresponding binomial weight and resultant value is shown in figure1 (d) .Binomial weight is shown in figure1(c).



LBP= 2+4+16+32+64+128= 246

Figure1: LBP description

When value of the entire pixel in 3×3 matrix is greater than threshold value then LBP will be 512. So the range of LBP will

be from 1 to 512.Finally the LEP histogram can be computed from

$H_e = N_m/N \quad m= 0,1,2,.....,512 \qquad (3)$

Where N_m is total numbers of pixel have LBP value m

3. PROPOSED ALGORITHM FOR OBSTACLE DETECTION

In this section, a new algorithm is proposed that helps to a blind person to navigate safely in surrounding environment. To sense an obstacle in the path a sound is introduced in the algorithm. During classification stage, the algorithm maps the new images as path or non path. A patch of pixel is considered as path if the color or LEP histogram of new image is matched with color or LEP histogram of any of sample images. A pseudo code of the algorithm is given below:

For K=1 to N

Fs=8000

y=[.9;.9;.9;.9]

If I (S,M_c, k) <threshold then

No obstacle in path (path is traversable)

Return

Else if I (S,M_e, k) <threshold then

No obstacle in path (path is traversable)

Else

Obstacle in path

Sound(y,Fs)

End

End if

End for

Here N is total number of images in training image set and S is new image taken by camera mounted on head of mobile robot, Mc and Me are the learned color and LEP histogram which are compared with sample histogram. .Threshold value is set by the experiment taken in challenging out-door environment.

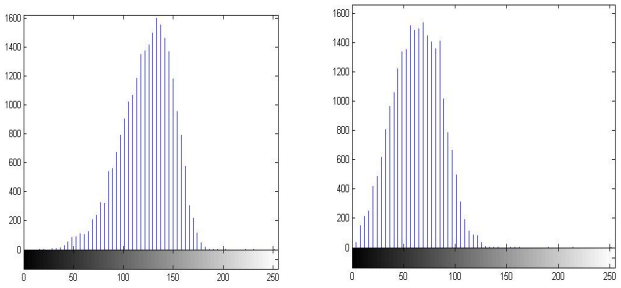
4. EXPERIMENTAL TESTS AND EVALUATION

In our experiment first a set of out-door images were collected from our campus COLLEGE. These images are divided into training set. All images in training set taken from camera are changed into 156*156 pixels. Then a new image taken from camera mounted on head of moving autonomous robot is compared with training set images. Comparison is done by color and LEP histogram method.

Many obstacles like people, car etc. are used in the traversable path. In our experiment people is considered as obstacle in the path. As color of surface changes dramatically color histogram in many cases gives false response (there is an obstacle in path). Texture feature are used when the color feature fails to correctly determine the obstacle in path.

(a) (b)

Figure2. sample of image taken at different time



(a) (b)

Figure3. Color histogram of of above sample images

Our algorithm uses the histogram matching method to detect an obstacle in path. Figure2(a)and Figure2(b) shows the same path but color illumination condition changes. The effect of these color are presented in color histogram of figure3(a)and figure3(b). LEP describes the spatiality distribution of pixel in image so there is no effect of color changes. To correctly determine the obstacle in path irrespective of color illumination condition color and LEP histogram is used. Our algorithm detects no obstacle when there color illumination condition changes as in figure2(a) and figure2(b).

In this algorithm threshold value is set by experiment carried out in out-door environment. Each histogram model has an associated with this threshold. A sound is played when histogram comparison method computes the value greater than experimental threshold. Algorithm uses texture feature[LEP] only when color histogram is not sufficient to locate an obstacle.

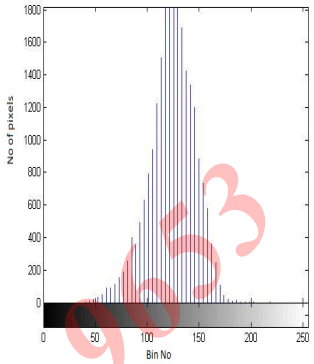
(a)

(b)

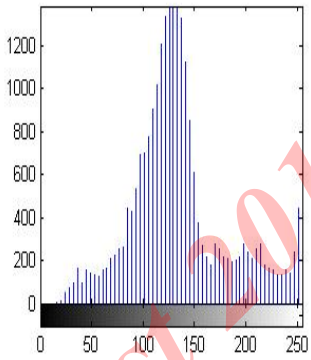
(c)

(d)

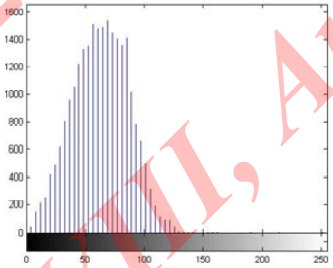
Figure4. sample image with and without obstacle



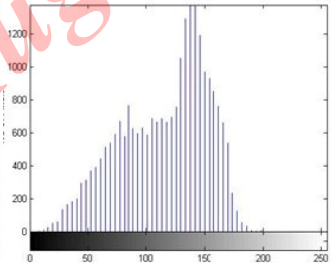
(a)



(b)



(c)



(d)

Figure5: Color histogram of sample images of figure1

Figure4 (a) 4(c) shows the image without obstacle and figure 4(b)4(d) shows the image with obstacle but color condition does not changes so color histogram is enough to determine obstacle in path. Color histogram matching method of figure5(b) and figure5(d) with figure5(a) and figure 5(c) compute the value which is greater than calculated threshold value and correctly determine the obstacle in path.

5. CONCLUSION

In this paper we proposed a new method to improve the efficiency of algorithm to find obstacle in path. To achieve better performance and efficiency to detect an obstacle in path of blind people a sound is played to help the blind people to recognize safe traversable path. Color and texture feature are used to implement the algorithm. Learning method of the

algorithm learns the set of color and texture feature and improves the performance of classification stage. A model of set of images is learned with color and LEP histogram of training set of images that is compared with newly image taken by camera. Learning method selected from the set of color and texture feature improves the classifier performance. As the algorithm works in challenging out-door environment it achieves a good tradeoff between performance and efficiency.

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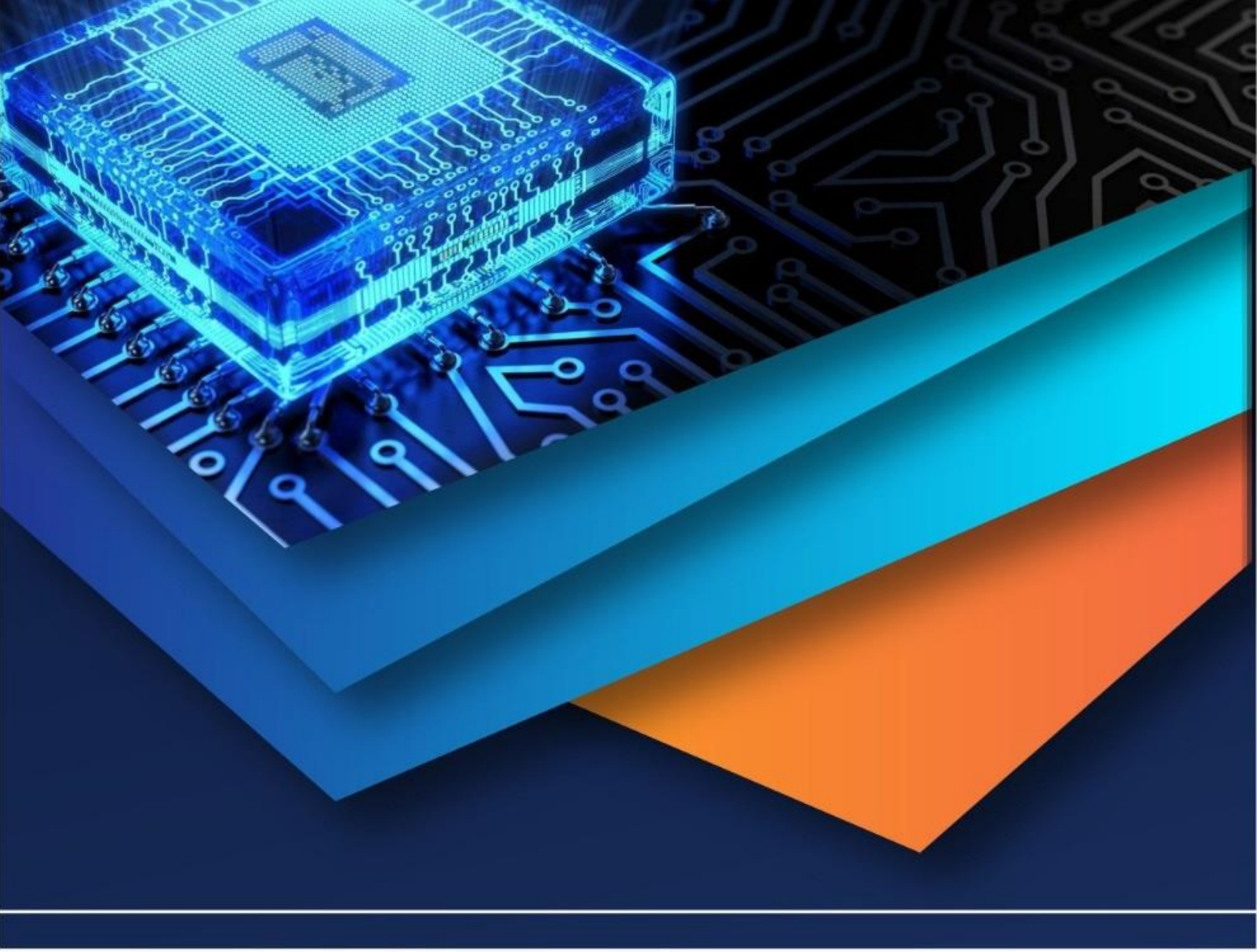

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