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An Intelligent Detection System Based Road Traffic Sign Recognition

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Abstract

Traffic sign detection and recognition systems provide an additional level of driver assistance, leading to improved safety for passengers, road users and vehicles. The automatic road-signs recognition is an important part of driver assisting systems which helps driver to increase safety and driving comfort. In this paper we proposed an efficient system for the detection and recognition of the road sign in the road and acquiring the traffic scene images from a fixed source.The road sign recognition system is divided into two parts, the first part is detection stage which is used to detect the signs from a whole image by using the shape filtering method, and the second part is the recognition stage where the traffic sign obtained is analyzed then the names and directions of cities are extracted using the artificial neural network (ANN).The system accuracy more than 90%.

Keywords: Traffic sign detection and recognition (TSDR), driver assistance, traffic sign, artificial neural network (ANN).

1.introduction

The main measure to reduce accidents on the roads is to be done in the development of systems that provide control of the vehicle while moving. To solve this problem, many researchers have made a lot of effort to trigger people interest in automatic driver technology[1].The first is normally related to the detection of traffic signs in a video sequence or image using image processing. The second one is related to recognition of these detected signs, which is deal with the interest of performance in artificial neural network[2]. The detection algorithms normally based on shape segmentation. The segmented potential regions are extracted to be input in recognition stage[3]. The efficiency and speed of the detection play important role in the system. To recognize traffic signs, various methods for automatic traffic sign identification have been developed and shown promising results. Neural Networks precisely represents a technology that used in traffic sign recognition [4].In literature work several traffic sign detection and recognition systems have been suggestedS. Maldonado et al. [5] used HSI color space for detection and then used SVM for classification of traffic signs. X.W.Gao et ale [6] applied the color advent model CIECAM97 to extract color information and extract the shape features by FASTS model to segment and classify the traffic signs. S. Prieto et al. [7] used a kind of ANN called SAM at every level of the detection and recognition of RSs. A.de la Escalera et al. [8] used an inherent algorithm for the detection step, agree to invariance localization, scale, rotation, weather conditions, partial occlusion. Then the classification is doneby using neural network classifier.In this paper the goal is to propose a new intelligent system to identify the road signs that could be used for intelligent vehicles. In these vehicles an image of road scene is captured by a camera and then the type of traffic sign is determined. The system has three major steps: Image preprocessing, traffic sign detection and objects extraction, and recognition.

This paper is organized in the following sequence. In Section 2 the traffic sign detection and recognitionalgorithm is described and conclusion is drawn on section 3.

2. The proposed algorithm for traffic sign detection and recognition

Traffic sign extraction is a process by which we convert imagewhich is obtained from a stationary source and at a distance of 10-15 metersand with fixed lighting and background and camera's resolution equals 20 Mega pixel, and with zoom equals 50 degrees.Where the names of the areas located in the traffic sign are identified through the computer and this is done through three main tasks to extract traffic sign they are:

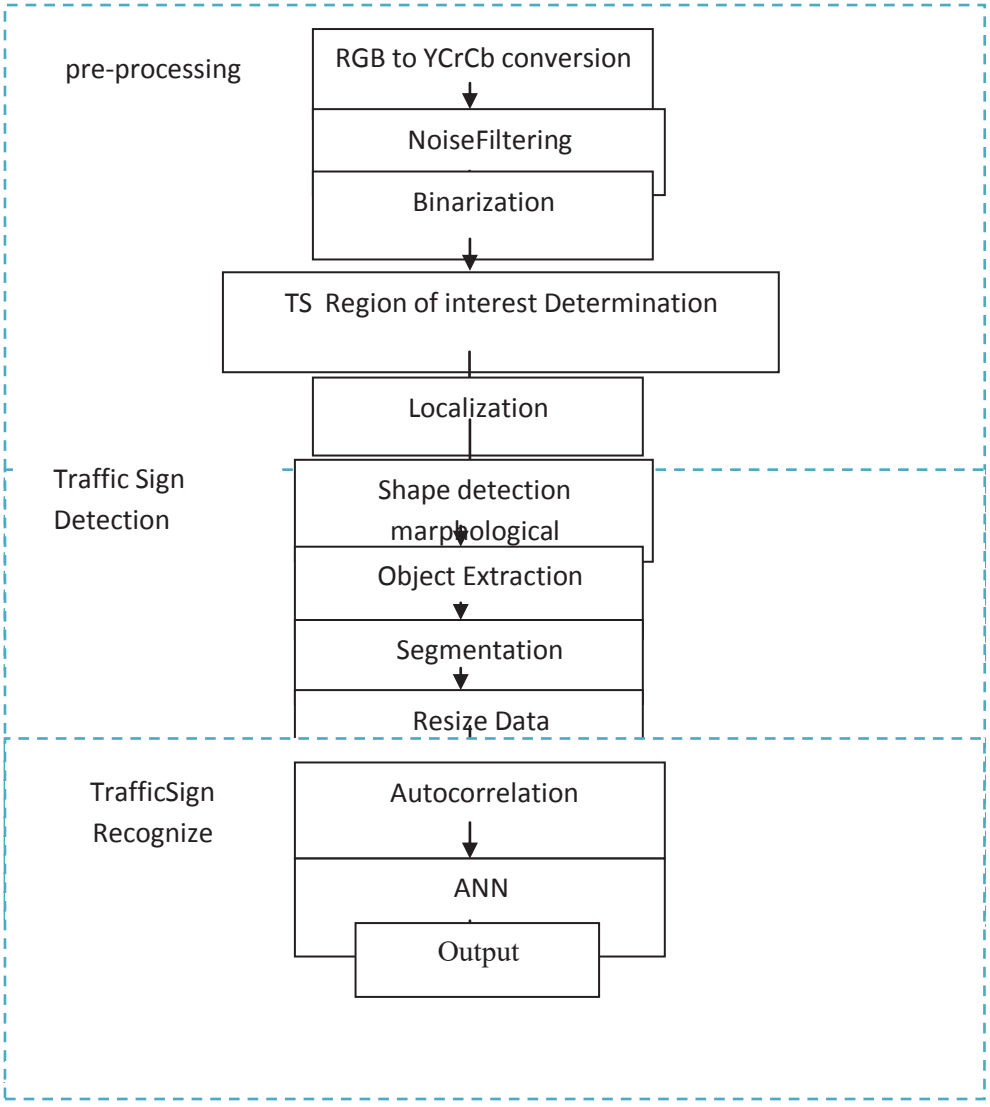
1- pre-processing.
2- traffic sign detection.
3- traffic sign recognition.

The main steps for the proposed system are shown in figure (1).

2.1pre-processing

After the image is taken from the camera, the image is converted from RGB to YCrCb for the purpose of easy handling, the noise filtered with size(3x3) Gaussian mask with Sigma, (σ = 0.5)[9].The image is then converted to a binary system using adaptive threshold for the purpose of performing the operations on it.Then we cut the region of interest from the image, it is noted that the region of interest is located at the top of the source image.

Source image:



The steps forregion of interest algorithm are:

Step 1: Calculate the size of the image (the image after the binary conversion) .

$$S = C \times R$$

where

S : size of the image, C= number of columns, R= number of rows.

Step 2: for the rows starts from the middle of the image :

for all column

BEGIN:

image(i,j)=0.

Where

i=R/2 to R, j=1 to C

Step 3: Make the bottom part of the image equal to zero, note that the bottom part of the image does not contain important information because the image traffic signal is at the top of the image .

After the cutting process; the important part of the image is done , we do localization processto detect the traffic sign region by bounders' box appended on vertical and horizontal, the horizontal and vertical projection profiles are defined as follows:

$$Hpp(\ ) = \sum_{Ls} : \text{Æ} ; \quad (1)$$

$$(\ ) = \sum_{Ls} : \text{Æ} ; \quad (2)$$

The steps for localization process are:

Step 1:Calculate horizontal project profile (HPP) by (1)

Step 2:Calculate vertical project profile (VPP) by (2)

Step 3:Remove small value of VPP and HPP.

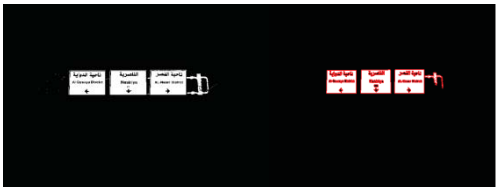
Step 4:Detect begin and end for VPP and HPP as bounders.

Step 5:Draw bounders' box.

The main steps for the preprocessing image are shown in figure (2).

Original color image

RGB to YCrCb Gaussian filter Binarization image



region of interestLocalization image

Figure(2):image pre-processing steps

2.2 Traffic sign detection

The process of detection includes the extraction of traffic sign and analysis. The following steps are taken:

2.2.1 Morphological

It is well-known that the goal of morphological process, based on dilation method, is to fill the holes or merge the adjacent or neighboring pixels. The design difficulty with this process is how to find the size of structural element. Size selecting is a compromise between blurring the image with almost white color or high calculation time. If one select small size of structural element, then, this would require high calculation time to scan the structural element over the whole image[10] . In the present work, a structural element of size 9x9 is chosen. The square box of structural element would be allowed to scan all the image area .The result of the morphological process is shown in figure (3).

(a):before morphological process (b):after morphological process

Figure (3): morphological process for image

2.2.2 Objects extraction

The method determines the segmenting when there is space between the objects .The global vertical projection method is used here to compute sum of all white pixels on every column .The steps for objects segmentation algorithm are:

Step 1: Construct the Vertical Histogram for the image.
Step 2: Count the white pixel in each column.
Step 3: Use the Histogram, find the columns containing no white pixel.
Step 4: Replace all such columns by 1
Step 5: Invert the image to make empty rows as 0 and objects will have original pixels.
Step 6: Mark the Bounding Box for objects.
Step 7: Remove any word or sub word image size small.

The applied algorithm is described in figure (4).

First image:

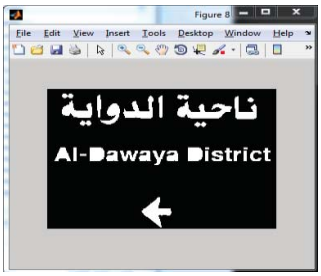
Figure (4): Objects (traffic sign) extraction

2.2.3Segmentation

The global horizontal projection method is used to compute sum of all white pixels on every row and construct corresponding histogram. The steps for line segmentation algorithm are:

Step1:Construct the horizontal histogram for the image.
Step2:Count the white pixel in each row.
Step 3:Use the histogram, find the rows containing no white Pixels.
Step 4:Replace all such row by 1.
Step 5:Invert the image to make empty rows as 0 and traffic sign will have original pixels.
Step 6:Mark the bounding box for traffic sign.
Step 7:Copy the pixels in bounding box and save in separate file.

You can see application of algorithm in figure (5).



(a):object 1

(c):line (1)(d):line 2(e):line(3)

(f):object2

(t):line (1)(h):line(2)(i):line(3)(j):line(4)

(k):object3

(m):line(1)(n):line(2)(o):line(3)

Figure (5):line segmentation

2.2.4 Resize data

The morphology processes are applied to the image of the names of the areas resulting from the cutting process. Removes interior pixels , in order to reduce the size of the data. This option sets a pixel to 0 if all its 4-connected neighbors are 1, so leaving only the boundary pixels on.As shown in figure (6).

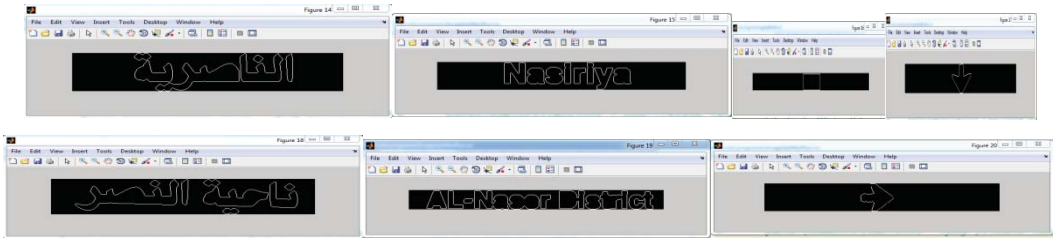


Figure (6): Reduce Data

2.3 Traffic Sign Recognition

Traffic sign recognition is an important main process in system; it converts word images to editable text its content some process. Because of difficulty in the recognition of Arabic text, we have some attempts to get the better results to recognize the Arabic text , English text and arrows direction extracted from image.

4- 2.3.1 Autocorrelation

Autocorrelation is a correlation coefficient. However, instead of correlation between two different variables, the correlation is between two values of the same variable at times x_i and x_{i+k} [11]. Given measurements, Y_1, Y_2, ..., Y_N at time x_1, x_2, ..., x_N, the lag k autocorrelation function is defined as[12]:

$$T_K = \frac{\sum_{i=1}^{N-K}(Y_i-\bar{Y})(Y_{i+K}-\bar{Y})}{\sum_{i=1}^{N}(Y_i-\bar{Y})^2} \qquad (3)$$

2.3.2simulation and results

We selected YCrCb because YCRCb is quite similar to the way in which humans perceive color and much more suitable for color segmentation because It gives unique information for different component of colors and Moreover the Y value is invariant for illumination which makes YCrCv color space one of the best choices for color segmentation. Using gaussian filter with size(3x3) and ($\sigma = 0.5$) give better filtering for image.To convert filtered image to binary we use thresholding (<50) ,this threshold is perfect for this type of traffic signs. Use of the morphology process gave great benefit in the process of cutting the shape, where we got the traffic signs. We used the vertical projection to extract the traffic signs forms. We used horizontal projection for the purpose of analyzing each part of the traffic signs to its components of Arabic and English texts and shares.Use autocorrelation for the purpose of accelerating network performance by reducing number of inputs and convert the data into real number data.The implicit benefit of using autocorrelation is to remove noise and reduce the size of data entering the neural network. The use of neural network gave results faster for recognition.

The ANN used in this algorithm has two layers (one hidden layer and output layer) number of neuron in hidden layer was 75 neurons and number of neuron in output layer was one neuron. The

activation function used in hidden layer was tangential function while the activation function used inoutput layer was linear function. The number of epoch selected to be 5000 epoch for each training phase .we selected35 sub images for training phase and 10 images used to test the valid of NN recognition.After the system was training ,the propsed system show accuracy result were more than 93% was recognition of the tested images. Reslt of recognition show in figure(6).

Figure(6): Reslt of recognition

5- Conclusion

In this paper, we proposed a new approach to detecting and recognition traffic signs.We used image processing concepts, where the morphological processes are used for the purpose of detecting the shape of the signal.Thevertical projections gave good results in the extraction of the signal from the background and the horizontal projections preference used to extract the names of the cities and trends.The use of the property of the autocorrelation for the final sub – images increase of the efficiency of the neural network result because it reduced the noise presented in image and also reduce the size of the ANN by reducing number of inputs; in which instead of using the whole image pixel to be input to the ANN, we used the lag presented by the autocorrelation process as described in equation (3) to give better recognition of the names of cities and their directions.

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