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Iranian Car License Plate Detection Using Color Image Processing

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***Abstract* – In this paper a new method for license plate detection for Iranian car plate based on color image processing is presented. In this approach, blue region in image of car plate are identified and then the location of plate is detected in image of car. The format of color image is converted to HLS format to apply the image processing. To identify blue region of car plate a Feed-Forward Neural Network (FFNN) has been used. After the identifying the blue region, to detect the plate location in car image the length to width ratio of plate is applied. Since proposed method is based on color image processing instead of the plate boundaries to determine the location of plate, is very vulnerable against the deformation of edge plate and flexible against the similar part of car, such as radiator region. Our proposed algorithm was implemented based on RGB and HLS color format and the results show significant correct location detection score in HLS format.**

***Keyword* – Car plate detection, Color images processing, Neural Networks, Color format**

1. INTRODUCTION

The importance of traffic monitoring and the recent improvement of automatic object tracking approaches increase the importance of intelligent transport. To identify the vehicles, features such as color, model and license number can be used. Since the license plate has unique information of a car, the car License Plate Recognition (LPR) has been studied for several years. The LPR system has several applications in traffic control, parking management and detecting stolen vehicles. The LPR system usually consists of three major steps: license plate detection, character segmentation and character recognition. The License Plate Detection (LPD) is the most important step in this procedure.

Thome and Robinault proposed an approach to identify various national plates. The optical character recognition is managed by a hybrid strategy [1]. Mao et, al. introduced a method using wavelet analysis and improved HLS color decomposition and Hough line detection [2]. Recently, license plate recognition has also been applied for car manufacturer and model recognition [3], [4]. Jiao and Huang presented four critical factors to deal with the multi-style plate problem: plate rotation angle, character line number, the alphanumeric types used and character formats [5]. Dlagnekov proposed a method to detect the license plate using an AdaBoost Classifier [6].

Generally the car plate detection approaches can be classified in two major categories for: boundary detection and gray value difference. To extract boundary line of a plate, several masks filtering technique and Hough are used [7],[8]. These methods are not strong enough to extract a plate region for the image whose boundary is deformed and require much memory and long execution time. Detecting methods which utilize the difference of gray value assume that a plate region has consistent gray value. Though these methods can deal with boundary deformation, they show weakness for an image with a non-plate region, which has similar gray value difference to a plate such as a radiator region.

Since in proposed method the location of license plate is recognized by using identification of color region in the plate, the deformation of plate edges does not have negative effect on plate location detection.

As illustrated in Figure 1, Iranian car plate consists of two major parts. Part 1, a white region and main part of plate, consists of characters of license plate and part 2, a blue region and small part of plate consists of the flag of Iran country. The blue region in the left part of plate can be used for recognizing the plate location in the car image.

In this method at first step an 8×8 window is placed on the image. The color features of the pixels in the window are applied in to the input of a neural network. The pixels of the blue region are extracted from the image in output of the neural network. After extraction the blue region, the exact location of the plate can be recognized according to a fixed ratio of length to width of plate and blue region. In Section 2 the models of color image will be presented. The neural network used in this approach is described in section 3 and also the extraction of the pixel of blue region will be explained in this

Fig. 1: An example of Iranian car plate

section. The implementation of proposed method is described in section 4 and finally the results of experiments are shown in section 5.

2. Models of Color Image

Unique blue region and its color combination in the image of plate is the main idea of extraction of the plate location by the color image processing. Therefore, the two main models of color image are explained and compared in this section. Initially, the color model of images produced by digital cameras is RGB. In this color model, each digital image is composed of three matrixes. Thus three numbers are attributed to each pixel. Each number respectively presents the value of RED, GREEN, and BLUE of each pixel.

The RGB model is suitable for color representation on visual systems, such as monitors and color printing, but this color model is not proper to feature extraction and pattern recognition in color image processing, since RGB model is not proper to represent tint, shade and tone in color images. Thus converting the color model of image from RGB to another model which is more suitable for image processing such as HLS format is very necessary. As shown in Figure 2, a HLS model can be represented as three dimensional color space which consists of Hue, Lightness, and Saturation .The vertical axis represents the lightness of color from white to black and the horizontal lines of the center cone shows the saturation of color and hue, type of color, is shown by an angle between the lines and the horizontal axis.

The color model of car images which is produced by digital camera is changed to HLS format in preprocessing. To compute the lightness and saturation from the values of R, G, and B, first defines three numbers M, m, and d as follows [9]:

$$\begin{aligned} M &= \max\{R, G, B\} \\ m &= \min\{R, G, B\} \\ d &= (M - m)/255. \end{aligned} \qquad (1)$$

The lightness L of a color is given by equation:

$$L = [(M + m)/2]/255 = (M + m)/510. \qquad (2)$$

The saturation S is given by the formula:

$$S = \begin{cases} \dfrac{d}{[1 - |2L - 1|]}; & \text{if } L > 0 \\ 0 \quad ; & \text{if } L = 0 \end{cases} \qquad (3)$$

The angle measures for H are calculated as:

$$H = \begin{cases} \cos^{-1}\left(\dfrac{(R - ½G - ½B)}{\sqrt{R^2 + G^2 + B^2 - RG - RB - GB}}\right) & ; \text{if } G \geq B \\ 360 - \cos^{-1}\left(\dfrac{(R - ½G - ½B)}{\sqrt{R^2 + G^2 + B^2 - RG - RB - GB}}\right); & \text{if } B > G \end{cases} \qquad (4)$$

According to property of HLS model color, this model is proper to color recognition in proposed method [6], [7]. After conversion RGB to HLS model, per pixel color features are used as inputs of neural network to extract the unique blue pixel.

3. Blue Pixel Extraction

Although blue color in all blue region of plaques is fixed, but according to the amount of lightness, darkness, blur of image and other unfavorable conditions the blue color value isn't constant for all the plate. Due to good performance of the neural networks in recognizing the noisy data and its high ability in pattern recognition and classification [8], using a neural network increases the blue pixel detection accuracy.

One of the important applications of Feed-Forward

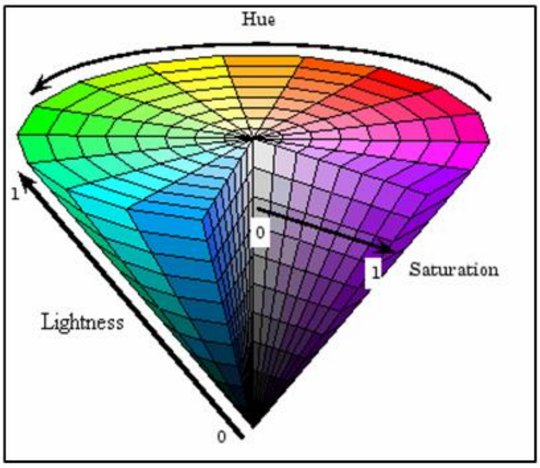

Fig. 2: Diagram of three dimensional HLS model

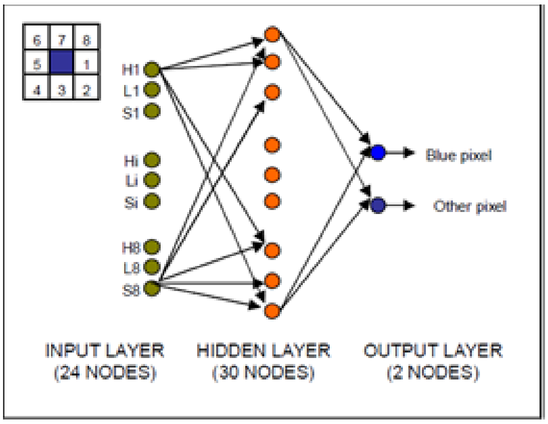

Fig. 3: Neural network for color extraction of a pixel color

Neural Networks (FFNN) is establishing the regular relationship between the values that finding the relation between them is difficult by other methods [10], [11].

In proposed FFNN, the active functions of the neurons of middle layer are chosen as nonlinear function, Tan-sigmoid, to relate between the inputs and outputs with nonlinear relationship. In the output layer the linear

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active functions are used, pure line, to cover the output domain. A standard back-propagation learning algorithm is used for training and testing.
To extract a color of a pixel, the HLS values of eight neighboring pixels around desired pixel are used in FFNN input. These surrounding colors are incorporated because they influence our perception of a pixel color.
This also plays a role of local smoothing operation by blending irrelevant pixels into larger color groups.
Figure 3 shows the proposed neural network for color extraction of a pixel. The number of the input neurons is 8×3 = 24 and the number of middle neurons is 30. One of the two output neurons represents the blue pixel and the other one shows the other color. A node of maximum value is chosen as the representative color. According to the neural network output, a binary image is created in which the value of blue pixel is 1 and the value of the other pixels is 0.

4. Implementation

The black pixels in binary image which are the blue pixels in primary color image are determined by vertical-horizontal histogram. Figure 4 shows the binary image and its histogram corresponding to the image of car which is shown in figure 1.
Since the width of the blue region and the plate are same, the number of the pixel in the length of the plate can be determine by using the constant ratio of length to width of the Iranian plate (k=5.1). Then based on the number of the vertical and horizontal pixels, the region of the plate

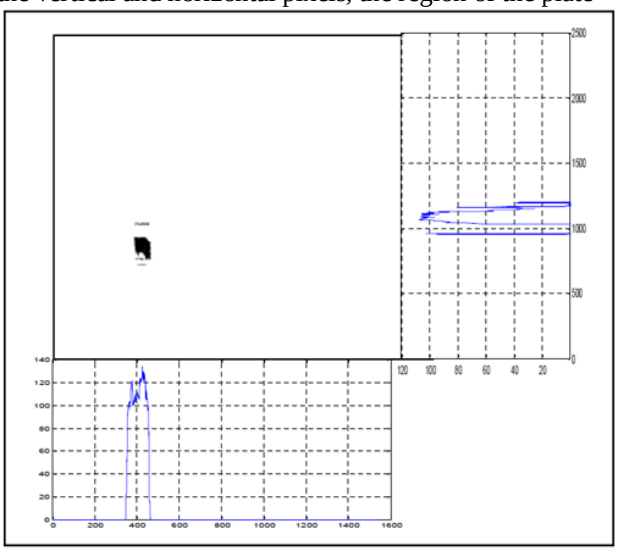

Fig. 4: horizontal-vertical Histogram of binary plate can be recognized in the image. In Figure 5, the plate location which recognized by proposed method is shown.

5. Experiment and Results

To experiment the proposed method, 120 images of front of cars were applied. A video camera is located at a fixed position to get images of moving car. The proposed method is implemented on a PC 486(50MHz) in MATLAB language and a Sony camera, by 10 Mega pixel resolutions, is used.
60 images are used in learning-set for training the neural network. After learning phase and determining the weights of NN, the other images (60 remained images) are used in test-set for testing the neural network.
In 55 images, from 60 images in test-set, the car plate location is properly recognized. This result is equivalent the 91.6%. The errors, in recognizing the plate location,

Fig. 5: the plate location which recognized by proposed method often occur in images of cars whose color is similar to blue region of the plate.
The experiments are done again with images in RGB model. The results are shown in the table 1.

Table(1) Recognition results(tota1 60 images)

RESLTS	RGB model	HLS model
Correct Recognition	20 / **60**	55 / **60**
Recognition Rate	33 %	91.6 %

6. Conclusions

A new method for license plate detection for Iranian vehicle plate based on color image processing is presented. To identify the blue region in car plate a Feed-Forward Neural Network (FFNN) has been used. In proposed FFNN, the active functions of the neurons of middle layer are chosen as nonlinear function, Tan-sigmoid and in the output layer the linear active functions are used, pure line. A standard back-propagation learning algorithm is used for training and testing. After the identifying the blue region, to detect the plate location in image the length to width ratio of plate is applied. Since proposed method is based on color image processing instead of the plate boundaries to determine the location of plate, is very vulnerable against the deformation of edge plate and flexible against the similar part of car, such as radiator region. Our proposed algorithm was implemented based on RGB and HLS color format and the

results show significant correct location detection score in HLS format.

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