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An Improved Bernsen Algorithm Steps for Turkish License Plate Number Recognition Using ANN

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Abstract: This article presents a license plate number recognition system vehicle for Turkish license plates. This article proposed steps for an improved Bernsen algorithm applied for the plate number recognition system. The proposed system is designed to extract the characters features of vehicle license plate numbers automatically from digital images. Also, this proposed technique is of three stages, the first is the detection technique which is based on an improved Bernsen algorithm, while the second technique is the segmentation of character in which Vertical and horizontal projection analysis techniques are used. The last stage is to recognize the characters, in which the letters and numbers are classified using an artificial neural network (ANN). In this article, a sample of 100 Turkish vehicle license plates were captured and tested, from the experimental result shows how the algorithm segment and recognize the characters very effectively.

Keywords: License Plate Recognition (LPR), Optical Character Recognition, Neural Network, Image Processing, Machine Learning.

INTRODUCTION

Plate number recognition is an artificially intelligent and advanced computer vision technology that is used in intelligent transport systems (ITS). Also, License plate number recognition involved image processing techniques that automatically detect the license plate image and recognized its characters on it without human intervention. It's a very important area of research that has a wide range of applications such as; speed control, automatic toll collection [Dhar, P. *et al*., 2018], road traffic control [Ullah, I. *et al*., 2017], and parking areas. It can also be applied in tracing stolen cars among others [Khorgade, K, 2019]. The attainment of license plate number recognition varies from the country; in some countries, their license plate is complex while others are simple. Therefore, the success of the license plate number depends on the simplicity and absence of illumination [Anagnostopoulos, C.N.E. *et al*., 2008]. The use of intelligent systems has brought a tremendous effect on our daily lives. Thus, most of the companies that are promoting computer vision research are now embedded into most of the intelligent systems to capture physical images and process them. This work aims to design and implement an efficient plate number recognition system with an intelligent device that operates in real-time [Kukreja, H. *et al*., 2020]. A desired licensed number plate for recognition system used digital image processing techniques for detecting and recognizing characters of the license plate number and produced an output result as characters as a string [Universit, A.A, 2016].

Plate number recognition consists of three major stages: the first stage consists of vehicle detection from license plate number, edge detection, and extraction techniques were used are among the techniques. the second stage is the segmentation of characters in which Vertical and horizontal projection analysis are the techniques used in the second stage. The last stage is recognizing the characters, and the letters and numbers are classified using an artificial neural network (ANN). This recognition of characters is part of the system which carry out by the ANN network [Jagtap, J. *et al*., 2018]. These processes are quite challenging because some of the images were taken with different backgrounds, angles of illumination, and different plate formats during image acquisition [Nejati, M. *et al*., 2015]. Some of these sample images are shown in Figure 1. To overcome such problems, an image enhancement technique can be applied, and a median filter was used to remove noise on the images to get a clear and readable image [Nejati, M. *et al*., 2015]. This article is a simulated plate number recognition system capable of identifying and recognizing of Turkey vehicle license plates.

LITERATURE REVIEW

A lot of research work has been done in the field of image processing and optical character recognition. Some of the existing algorithms and methods used for the detection, segmentation, and recognition of license plates have not been applied to corrupted images from the real world. However,

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some of the existing algorithms and techniques for segmenting characters have not been effectively applied in degraded images from the real world. In [Kukreja, H, 2020], one of the methods used in detecting license plates is by using binarization, to eliminate the unnecessary regions from the license plate image. This method is carried out based on the contrast between characters and background in the license plate. One of the disadvantages of this method is taking longer processing time. Also, some researcher has proposed various methods of locating license plates, which include the window method [Khorgade, K, 2019], edge detection method [Ganesan, P. *et al*., 2017], and line-sensitive filters to extract the plate areas [Danbatta, S.J. *et al*., 2016]. All these algorithms have the advantage to process the license plate's location, also they possess certain disadvantages which include sensitivity to brightness, and a lack of versatility in adapting to the varying environment. An efficient technique which is called the improved Bernsen algorithm is developed to detect a license plate in various luminous conditions. This algorithm is used to extract the license plate data from an image and provides it as an input to the stage of license plate number recognition.

METHODOLOGY

The developed systems aim to identify and recognize Turkish vehicle license plates. the input to the system is the license plate image captured by the digital camera, and the output of the system is the detected and recognized license plate image. The program developed is implemented on MATLAB 8.2. The implementation of procedures is in three stages:

License Plate Detection Algorithm

The block diagram of license plate detection and recognition of an improved Bernsen is shown in figure 1.

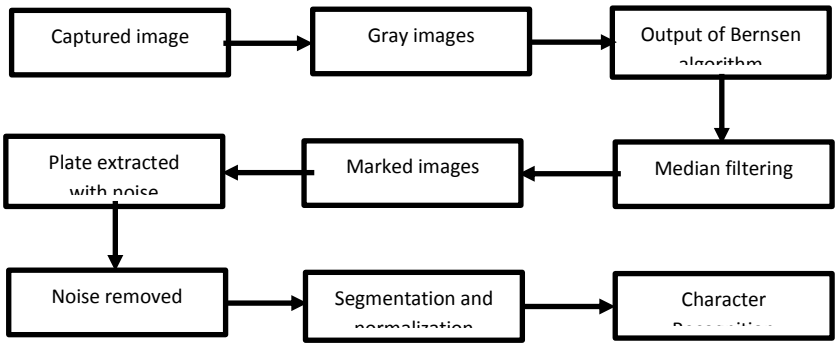

Figure 1: Block diagram of the Bernsen algorithms.

Bernsen Algorithm

This is a pre-processing step in license plate detection. This algorithm, i.e. (the Bernsen algorithm), is proposed as the appropriate solution to the problem of uneven solution obstacles, particularly for shadow images. Let f (x, y) denote a gray value of the point (x, y), by considering a block whose center is a point (x, y) and the size is (2w+1) *(2w+1). The threshold T (x, y) of f(x, y) is calculated by:

$$T_1(x,y) = \frac{\max_{-w\le k;l\le w} f(x+l,y+k) \; + \; \min_{-w\le k;l\le w} f(x+l,y+k)}{2} \qquad (1)$$

Also, the binary image is obtained by

$$b(x,y) = \begin{cases} 0, if\ f(x,y) < T_1(x,y) \\ 255, else. \end{cases} \qquad (2)$$

Because the Bernsen algorithm is very susceptible to noise, which disturbs the plate characters' extraction, removing the noise and maintaining the characters is of paramount importance. Suppose that $\hat{f}(x,y)$ is the gray value obtained with the Gaussian filter, σ is the scale of the Gaussian filter, k, and l are the parameters of the window. An improved Bernsen algorithm has the following steps:

Step 1: Calculate the threshold $T_1(x,y)$ of $f(x,y)$ base of equation (1) above, i.e.,

$$T_1(x,y) = \frac{\max\limits_{-w\le k;l\le w} f(x+l,\ y+k) \; + \; \min\limits_{-w\le k;l\le w} f(x+l,y+k)}{2}$$

Step 2: Create the Gaussian filter for the window, $s = (2w+1) * (2w+1)$ i.e.,

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$$\hat{f}(x,y) = \frac{1}{(2w+1)^2} \sum_{x,y \epsilon S} f(x,y) * exp\left\{-\frac{1}{2}\left[\left(\frac{x}{\sigma}\right)^2 + \left(\frac{y}{\sigma}\right)^2\right]\right\} \quad (3)$$

Step 3: Compute the threshold $T_2(x,y)$ of $\hat{f}(x,y)$ as

$$T_2(x,y) = \frac{\max_{-w \le k,l \le w} \hat{f}(x+l,y+k) + \min_{-w \le k,l \le w} \hat{f}(x+l,y+k)}{2} \quad (4)$$

Step 4: Obtain a new binary image as

$$b(x,y) = \begin{cases} 0, if\ f(x,y) < \beta\big((1-\alpha)T_1(x,y) + \alpha T_2(x,y)\big);\ \beta \epsilon (0,1) \\ 255, \qquad else. \end{cases} \quad (5)$$

Where α is a parameter to adjust the balance between the traditional. Bernsen algorithm and the new Bernsen algorithm i.e., the Bernsen algorithm with Gaussian filter $\alpha\ \epsilon([0,1])$. If α is equal to 0, then the proposed algorithm is the traditional Bernsen algorithm, still, if α is equal to 1 then the proposed algorithm is the Bernsen algorithm with a Gaussian filter. So by changing the appropriate value of α, the shadow removal can easily effectively easily removed, and the characters of the license plate can be successfully identified.

Step 5: Apply the median filter to remove the noise.

$\alpha\ and\ \omega$ have a significant impact on processing results in this algorithm

Figure 2: Shows a Grayscale and Histogram of the license plate

Dilation of Bernsen Algorithm

Based on the block diagram above, after obtaining the median filter image, the morphological dilation operation is applied [Ullah, I. *et al*., 2017]. Dilation is the process of adding pixels to the boundaries of an object in an image. i.e., joining the broken lines, sharpening the edges of the object in an image, which increases the brightness of the images. Using the dilation operation means the noise within the model can also remove. The difference in gray value between neighboring pixels at the edge of an object can be increased, by making the side sharpen, all this process improves the edge detection. In (LPNR), the images of a plate always contain brightness and shades. Therefore, the input images have to be converted from RGB to grayscale foam. The dilation operation is usually used for probing and expanding the edge and sharpening contained in the input image.

License Plate Location

The next step is to locate the license plate (plate extracted with noise). The result of the location is the key to the following work, which directly affects the performance of the entire system. Connected component analysis (CCA) [Shawal, S. *et al*., 2014], is an essential technique in motion detection. This technique usually scans an image and labels its pixels into components based on pixels' connectivity, (i.e., either eight connected or four connected). (CCA) works on gray level or binary images, and every binary image contains two levels black and white or (0 and 255); these binary images represent the background and foreground pixels. The object is extracted using the CCA technique, which contains a unique label for each maximal connected foreground pixel. The two detection methods for license plate are: (a) the first methods are the detection of a white frame with CCA (i.e., the candidate's structures are detected based on prior knowledge of the license plate), and (b) the second method is the detection of black characters with CCA (i.e., license plate location without a frame who detects the plate by extensive numerical extraction).

Accurate Position Based on Horizontal and Vertical Projection Method

In this step, to segment and recognize the character accurately, it's necessary to process the approximate positioning of the license plate. In (The, W. Academy), horizontal and vertical correction is the methods required before character

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segmentation. A horizontal first-order difference is carried on rough location image f to achieve the horizontal accurate image r. the horizontal correction can be described by the equation below:

$$r(i,j) = \left|f\left(i,j - f(i,j-1)\right)\right|, \quad where\ i = 1,2,3,\dots m, j = 2,3,4,\dots n \tag{1}$$

$r(i,j)$ is the pixel value of the image r, $f(i,j)$ is the pixel value of the image f, also m and n are the height and width of the image f. The correction value of the row i named $T_1(i)$can be calculated by collecting the pixel value of image r per row, as shown below:

$$T_1(i) = \sum_{j=2}^{n} r(i,j) \tag{2}$$

Considering the edge of the image is not smooth enough, then, the average value is used as $T(i)$ to search the boundary efficiently. The equation can be expressed as follows:

$$T_1(i) = \frac{T_1(i-1)+T_1(i)+T_1(i+1)}{3} \tag{3}$$

After obtaining the equation (3) above, the statistic of each row is saved in the sum (i) array, where (i) is the corresponding row. Analyzing the horizontal correction value, the character regions are generally corresponding to the intermediate dense high region which accounted for a position, in this process the license plate can be located accurately in the vertical direction. The algorithm can be described as follows:

i. By setting the 0.6 of the maximum value of sum (i) as a threshold
ii. From left to right, study the array sum (i) to find the first element value which is bigger than the threshold, taking down the index of the value as m;
iii. Also from left to right, study the array sum (i) to find the first element value which is bigger than the threshold, taking down the index of the value as n;
iv. Extracting the image between the rows, i.e., row m and n as the accurate position in a vertical direction.

Also, the vertical correction is applied to locate the license plate accurately in the horizontal direction. This equation can be illustrated as:

$$g(i,j) = \left|r\left(i,j - r(i,j-1)\right)\right|, \quad where\ i = 1,2,3,\dots m, j = 2,3,4,\dots n \tag{4}$$

$r(i,j)$ is the pixel value of the image r which has been processed in the equation above, $g(i,j)$ is the pixel value of the image g, also m and n are the height and width of the image g. The correction value of the column i named $T_2(i)$ can be calculated by collecting the pixel value of image r per column, as shown below:

$$T_2(j) = \sum_{i=2}^{n} g(i,j) \tag{5}$$

Considering the edge of the image is not smooth enough, then, the average value is used as $T(i)$ to search the boundary efficiently. The equation can be expressed as follows:

$$T_2(j) = \frac{T_2(j-1)+T_2(j)+T_2(j+1)}{3} \tag{6}$$

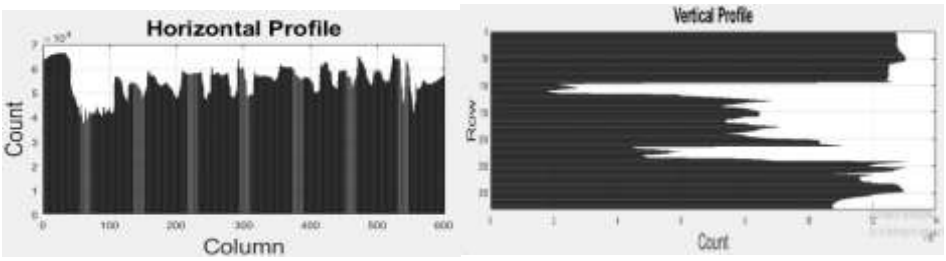

Figure 3: Horizontal and vertical projections.

Here, the statistic of each column is saved in the sum (j) array, where j is the value corresponding column. Analyzing the horizontal correction value, the character regions are generally corresponding

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to the intermediate dense high region which accounted for a position, in this process the license plate can be located accurately in a vertical direction. The algorithm can be described as follows:

i. By setting the 0.7 of the maximum value of sum (j) as a threshold
ii. From left to right, study the array sum (j) to find the first element value which is bigger than a threshold, taking down the index of the value as m;
iii. Also from left to right, study the array sum (j) to find the first element value which is bigger than the threshold, taking down the index of the value as n;
iv. Extracting the image between the columns, i.e., column m and n as the accurate position in a vertical direction.

Character Segmentation

In [Bal, C. *et al*., 2022], Image segmentation is the process of subdividing an image into the constitutes parts or objects in an image. The purpose of dividing an image into its constitutes parts or objects present in the image is to further analyses to extract some information so that information is useful for high-level machine vision applications. In this step, by using the number of alternating white and black method. After obtaining the extracted and accurate positioning image of a license plate, the character segment is reached as [Liu, X. *et al*., 2019]. To get the images containing only the character, it is natural to search for the starting and ending points of each character. An algorithm base on calculating the number of blacks and white transformations per column is presented. The algorithm steps are illustrated below:

Gray-scale image is converted to a binary image using the Otsu method [Ganesan, P. *et al*., 2017].
An array T(j) was created to store the transformation value of each column, where
j=1,2 …n is the index of each column, and n is the width of the license plate image with an initial value of zero.
Each pixel value searched per column from up to bottom, if the pixel value changes from 0 to 1 or from 1 to 0, it is defined as the transformation, and then one is added to the corresponding value of the column $T|j|$; else, the original value remains as it is.
By drawing the histogram of $T|j|$; until the last column is completely processed.

Figure 4: Extraction and segmentation of the license plate images

Character Recognition

The final stage in license plate number recognition is the recognition of characters, which is the most difficult stage in character recognition. There are a lot of recognition algorithms that can be used in the recognition of characters. In this paper, template matching is one of them and can be used in identifying the characters. Character recognition technology is an essential technique in character recognition. Train up the different font styles of the alphabet and numerical in the optical character recognition system. The license plate with different styles can be easily recognized, and the final output can be displayed in a notepad.

RESULTS OF THE EXPERIMENT

In this article, 100 images of a Turkish vehicle's license plates were tested using a white background as shown in figure 5. The vertical and horizontal projection algorithm can efficiently separate each character of the license plate. The Bernsen algorithm proposed in this article is used in black characters on a white background.

Figure 5: Some of the license plate numbers from Turkey (Private)

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Type of Architecture	Type of license plate	True/False
Net1 MLP 123_36 tansig_tansig	23HC353	True
	238J721	False
	238S611	False
	23EN375	True
	73ES352	False
	23K318S	True
	23LH553	True
Net21 PTRN 63_36 tansig_softmax	23BC353	True
	23BJ729	True
	23BS611	True
	23EN375	True
	23FS352	False
	23K318G	True
	23LH553	True
Net3 MLP 36_36 tansig_tansig	23BC353	True
	23BJ729	True
	23BS611	True
	23EN375	True
	23ES352	True
	23K3184	True
	23LH553	True
Net5 PCRN(hardlim) 36	Z0RL000	False
	ZZ0JTZ0	False
	Z00SSTT	False
	7ZRNJ75	False
	700S007	False
	Z0K0T0G	False
	70LR550	False
Net7 PTRN 123_36 tansig_softmax	23BC353	True
	23BJ729	True
	Z3BS6TJ	False
	23EN375	True
	23ES35Z	False
	23K3184	True
	Z3LH553	False

CONCLUSION

The work pays attention to a solution for image disturbance ensuing from uneven illumination and various outdoor condition like shadow and exposure, which generate difficulty in obtaining successful processed results. The proposed technique would divide the characters of plate numbers effectively based on the segmentation technique as shown in the experiment. This proposed algorithm is an effective technique to recognize the Turkish license plate. It could also be improved to recognize some other countries' license plates, especially most African countries like Nigeria, Niger, and Ghana.

REFERENCES

1. Dhar, P., Guha, S., Biswas, T. and Abedin, M.Z. "A System Design for License Plate Recognition by Using Edge Detection and Convolution Neural Network." *Int. Conf. Comput. Commun. Chem. Mater. Electron. Eng. IC4ME2 2018* (2018).
2. Ullah, I. and Lee, H.J. "An Approach of Locating Korean Vehicle License Plate Based on Mathematical Morphology and Geometrical Features." *Proc. - 2016 Int. Conf. Comput. Sci. Comput. Intell. CSCI 2016* (2017): 836–840.
3. Khorgade, K. "Security for Campus Vehicle by Automatically Recognition of Number Plate with Notification." *Int. J. Res. Appl. Sci. Eng. Technol.* 7 (2019): 3983–3985.
4. Anagnostopoulos, C.N.E., Anagnostopoulos, I.E., Psoroulas, I.D., Loumos, V. and Kayafas, E, "License plate recognition from still images and video sequences: A survey." *IEEE Trans. Intell. Transp. Syst.* 9 (2008): 377–391.

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5. Kukreja, H. "An introduction to artificial neural networks." *Hardw. Archit. Deep Learn* (2020): 3–26.
6. Universit, A.A. "MATLAB Code of Artificial Neural Networks Estimation MATLAB Code of Artificial Neural Networks Estimation." (2016).
7. Jagtap, J. and Holambe, S. "Multi-Style License Plate Recognition using Artificial Neural Network for Indian Vehicles." *2018 Int. Conf. Information, Commun. Eng. Technol. ICICET 2018*. (2018): 1–4.
8. Nejati, M., Majidi, A. and Jalalat, M, "License plate recognition based on edge histogram analysis and classifier ensemble." *2015 Signal Process. Intell. Syst. Conf. Sp. 2015* (2016): 48–52.
9. Ganesan, P. and Sajiv, G. "A comprehensive study of edge detection for image processing applications, *Proc. 2017 Int. Conf. Innov. Information, Embed. Commun. Syst. ICIIECS 2017*. (2018): 1–6.
10. Danbatta, S.J. and Mohammed, N.D. "Nigerian License Plate Using Bounding." 2 (2016): 239–244.Shawal, S., Shoyab, M. and Begum, S. "Fundamentals of digital image processing and basic concept of classification." *International Journal of Chemical and Process Engineering Research* 1.6 (2014): 98-108.
11. The, W. Academy, Performance Analysis on Automatic Number Plate Recognition System and Methods Performance Analysis on Automatic Number Plate Recognition, (n.d.).
12. Bal, C., Yunusa, A.S., Abdu, A.M., Abdullahi, A.A., Musa, A.L. and Sani, A.M. "Plate Number Recognition Using Segmented Method With Artificial Neural Network." (2022): 1–5.
13. Liu, X., Deng, Z. and Yang, Y. "Recent progress in semantic image segmentation." *Artificial Intelligence Review* 52.2 (2019): 1089-1106.

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