Proceedings of the World Congress on Engineering and Computer Science 2011 Vol I
WCECS 2011, October 19-21, 2011, San Francisco, USA

Novel Edge Mapping for License Plate Detection

Suprava Patnaik, Chirag N. Paunwala, Mirah Shah and Sulay Shah

Abstract— **License Plate Detection plays an important role in traffic security and accessing owner's information. Contrast enhancement is essential to improve signal to noise ratio in detection of License Plate. Here we introduce a new approach of edge enhancement for enhancing license plates after improving the contrast by using Contrast Limited Adaptive Histogram Equalization. This method can be used for better edge analysis of degraded images and is very robust to intensity variation due to speckle noise arisen out of coherent summation of reflections associated with night capturing. Results with different conventional methods are compared at the end.**

Index Terms— **Contrast Limited Adaptive Histogram Equalization, edge detection, License Plate Localisation**

I. Introduction

CONTRAST enhancement has always showed improved results for a variety of image processing applications such as digital photography, medical image analysis, remote sensing, LCD display processing, and scientific visualization. Several contrast enhancement techniques have been introduced to improve the contrast of an image. These techniques can be broadly categorized into two groups: direct methods and indirect methods [4], [5]. Direct methods define a contrast measure and try to improve it. Indirect methods, on the other hand, improve the contrast through exploiting the under-utilized regions of the dynamic range without defining a specific contrast term. Most methods in the literature fall into the second group. Indirect methods can further be divided into several subgroups:
i) Techniques that decompose an image into high and low frequency signals for manipulation, e.g., homomorphic filtering.
ii) Histogram modification techniques [3,4]
iii) Transform-based techniques. Out of these three subgroups, the second subgroup received the most attention due to its straightforward and intuitive implementation qualities.

Detecting edges in an image plays a vital role for image analysis and to obtain intricacies of the image. One of the widest applications of doing image analysis based on edge map of the image is object recognition. Various techniques based on Histogram modification for contrast enhancement has been proposed. This includes histogram specification, histogram equalization, local histogram equalization adaptive histogram equalization, Gray Level Grouping and many other. Each of the methods has some limitations and cannot improve the quality or detect the edges of very degraded and poor images. For instance the global HE method cannot adapt to local brightness features of the input image because it uses histogram information over the whole image. This fact limits the contrast-stretching ratio in some parts of the image, and causes significant contrast losses in the background and other small regions. Local histogram specification removes the limitations of Global Histogram Equalization but it is slow and does not give good edge enhancement for poor quality images. GLG is automatic but not too much effective for poor quality images. All the above methods have limitations of poor edge detection and this limits its usefulness for proper License Plate extraction. Here we propose to enhance image contrast using CLAHE (Contrast Limited adaptive Histogram Equalization) which removes the limitations of traditional HE techniques. However alone CLAHE cannot give good results for License Plate Detection for very poor quality image. Hence we introduce a novel approach to enhance the edges for our application. The technique which we propose here gives fairly good result for obtaining an edge map of even degraded and poor images.
The rest of this paper is organized as follows. In section II we have described CLAHE and our novel approach for edge enhancement is described in detail in section III. In section IV we have compared the edge map of other techniques and our approach and also have presented experimental results. Conclusion is presented in section V.

II. CONTRST LIMITED ADAPTIVE HISTOGRAM EQUALIZATION

According to the characteristic of human vision, the visual systems change with the variations of intensity in relative region and they are affected by the surrounding environment. Contrast Limited Adaptive Histogram Equalization (CLAHE), is an improved version of AHE, or Adaptive Histogram Equalization, both overcome the limitations of standard histogram equalization. The CLAHE algorithm partitions the images into contextual regions and applies the histogram equalization to each one. This segments out the distribution of used gray values and thus makes hidden features of the image more visible [3] after local histogram equalization. The full grey spectrum is used to express the image. If the spectrum size is kept small poor contrast is obtained and if this size is kept large

Manuscript received August11, 2011;
Suprava Patnaik is with Sardar Vallabhbhai National Institute of Technology ,Surat, GJ 395007, India ,phone: 9904402677; fax: 91-261-222-7334; e-mail: ssp@ eced.svnit.ac.in
Chirag N Paunwala is with Sarvajanik College of Engineering Technology, Surat, Gujarat; email: cpaunwala@gmail.com
Mirah Shah graduated from Sardar Vallabhbhai National Institute of Technology, Surat, India,email: mraj7789@gmail.com
Sulay Shah graduated from Sardar Vallabhbhai National Institute of Technology, email:sulayshah08@gmail.com.

computational time is required hence optimum grey spectrum size is needed to be selected. If N_x and N_y are respectively number of pixel in x and y direction on the contextual region then average number of pixel is given by

$$N_{avg}=(N_x*N_y)/N_g \qquad \text{.............. (1)}$$

Where N_g is the number of gray levels in the contextual region.

Fig.1 Flow chart

We define the actual clip limit as below

$$N_c = N_{clip}*N_{avg} \qquad \text{................ (2)}$$

N_{clip} is the maximum multiple of average pixels in each gray level of the contextual region. If the number of pixels is greater than N_{clip}, the pixels will be clipped. N_c is a contrast factor that prevents over-saturation of the image specifically in homogeneous areas. These areas are characterized by a high peak in the histogram of the particular image contextual region due to many pixels falling inside the same gray level range. These areas of histogram are clipped by setting appropriate clip limit (N_c).

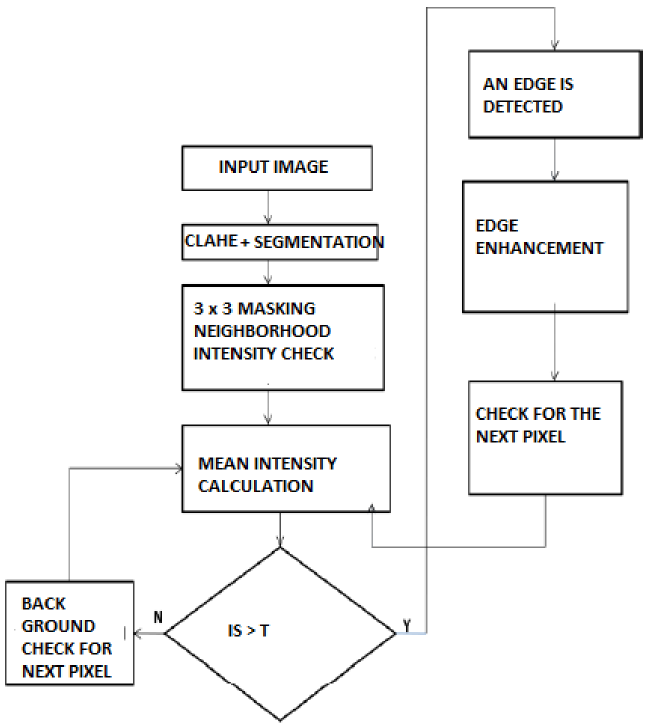


Fig 1.: Block Diagram

If we increase the clip limit the saturation of the image increases. Higher values result in greater dynamic range at the cost of slower processing speed. We can take many histogram transform functions for the contextual region. The transform taken in this approach is „uniform" transform. This is flat histogram. Each context region"s contrast is enhanced, so that the histogram of the output region approximately matches the histogram specified. The result mapping at any pixel is interpolated from the sample mappings at the four surrounding sample-grid pixels. If the pixel mapped is at location (x, y), the intensity is I, m1,m2,m3,m4 be upper right, lower right, lower left and upper left pixel of (x, y) Then the interpolated AHE result is given by [4]

$$M(i) = a([bm_4(i) + (1-b)m_1(i)] + (1-a)[bm_3(i) + (1-b)m_2(i)] \qquad \text{.....(3)}$$

Where $a = \dfrac{y - y1}{y2 - y1}$ and $b = \dfrac{x - x1}{x2 - x1}$

where y1 and y2 are adjacent pixel at y and x1 and x2 are adjacent pixel at x. Thus by this bilinear interpolation new enhanced image I is obtained.

m4		m1
	M (x,y)	
m3		m2

Fig.2: Interpolation

III. EDGE ENHANCEMENT

For edge detection we use the concept of Image Segmentation. After processing image from CLAHE, we first determine the threshold that will segment the image into regions. We use adaptive thresholding method to determine this threshold. For adaptive thresholding consider the fig 3.a and its histogram fig 3.b.

Fig. 3.a Image with a License Plate

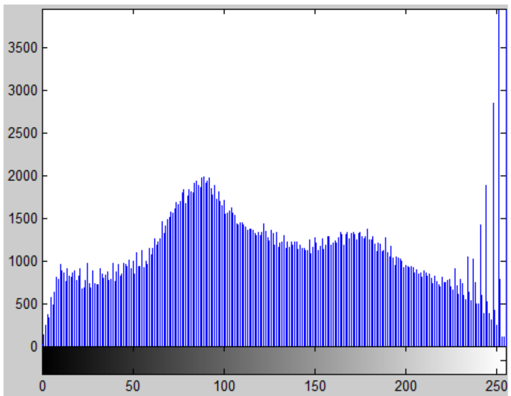


Fig 3.b Histogram of 3.a

Now to segment this histogram in two regions, initially a

ISBN: 978-988-18210-9-6
ISSN: 2078-0958 (Print); ISSN: 2078-0966 (Online)

threshold t0 is selected. This t_0 will segment the histogram into two regions. Now, compute the mean intensity value of region I (gray values less than t_0) and that of region II (gray values greater than t_0). Let their mean intensity values be m_1 and m_2 respectively. Now compute new threshold t_1 such that,

$$t_1 = \frac{m_1 + m_2}{2} \quad \ldots\ldots.(4)$$

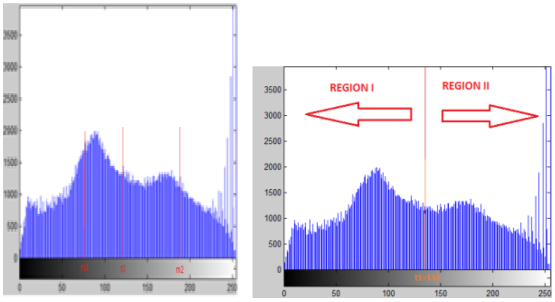


Fig (3.c) Segmentation Fig (3.d)final threshold ϵ =3

If $|t_1 - t_0| < \varepsilon$ then t_1 becomes final threshold.

Else-if $|t_1 - t_0| \geq \varepsilon$ then t1 is used to separate two new regions and the process is repeated. In the above example after computing final threshold at t1=134 (fig(2-d)), we finally get two regions, region I and region II separated at t_1.

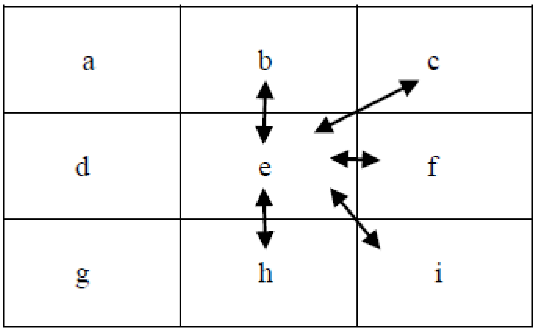


Fig 4: 3X3 Sub block

Now the next step is to enhance the edges in the image. For this purpose consider a 3x3 sub block centred at *e* and with intensity *I(i, j)* as shown in the fig. (3). We then compare intensities of centre pixel and its neighboring pixel pair, here *(e,b),(e,c),(e,f),(e,i) and (e,h).* The rest intensity pairs are not included as those have already been identified when the sub-lock was selected with center at *d*. Our motivation is based on the fact that if two neighbouring pixel belong to different regions (I and II) then there is a possibility of pixel being on the edge. Associated edge can be enhanced further by modulating the pixel intensities more towards the mean of their respective classes.

If C_1 and C_2 are the two segments with $mean(C_1) < t_1$ and $mean(C_2) > t_1$, then for two neighbouring pixels, let for *e* and *f* , following are the possible cases and actions,

Case-I: $e \in C_1$ and $f \in C_1$, No action

Case-II: $e \in C_2$ and , $f \in C_2$ No action

Case-III: $e \in C_1$ and $f \in C_2$,

$$I(e) = t_1 - d \quad \text{and} \quad I(f) = I(f) + d$$

Action: $I(e) = I(e) - T$ and $I(f) = I(f) + T$

Case IV: $e \in C_2$ and $f \in C_1$

$$I(e) = I(e) + d \quad \text{and} \quad I(f) = I(f) - d$$

Action: $I(e) = I(e) + T$ and $I(f) = I(f) - T$

Where *d* is the edge gap margin which can decide how much strong edge has to be detected. If value of *d* is large then very strong edges are detected if value of *d* is decreased more and more weak edges are detected.

Once edge is detected the smaller and the greater intensity pixel is found, the intensity value of the one which has higher intensity is made more higher by *T* amount and the intensity value of the one which has lower intensity is made lower by *T* amount. By doing this the difference between the pixel intensities representing the edge is increased and edge enhancement takes place. This enhancement takes place only for edges. Hence flat regions are not unnecessarily enhanced. Here we have kept value of *T* as 30. Again *T* can have different values taking signal to noise condition into account. For low contrast image larger values of T leads to weak edge extraction.

IV. Experimental Results

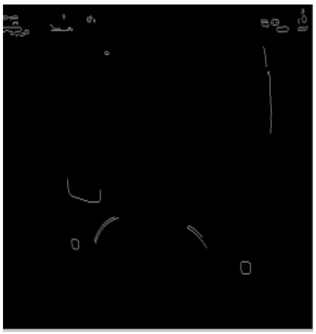
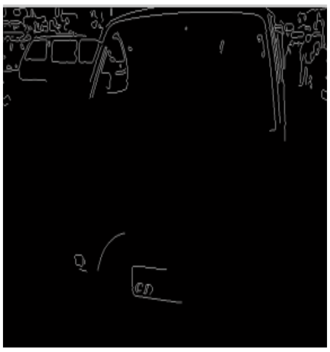
In order to have a better insight we compare the edge map of same image with three different contrast enhancement techniques. We use “Canny” operator for edge detection. Also in the proposed technique we can have different threshold of canny operator for dark and bright images. Here we have adjusted the threshold of canny operator as 0.25.

Binarization, vertical edge detection and edge density map generations processes play significant role to localize a license plate. However when applied on images with skewed illumination or multisource scattering common edge detection operations like Sobel or Canny fails to detect edges accurately. We have implemented our proposed algorithm for License Plate Localisation application.

Edge map obtained by both Histogram equalization, GLG and the proposed method has been compared in the table above. Here the purpose is used to detect the license plate, which requires accurate edge detection and edge density analysis. By performing Histogram equalization or GLG and then finding edge map, it has been observed that the required edges of License plate are absent whereas it is obtained by using the proposed method as shown in the last column of the table-I. Applying processing like edge projections and connected component analysis on the proposed enhanced edge map image will lead to accurate localization of License Plate.

ISBN: 978-988-18210-9-6
ISSN: 2078-0958 (Print); ISSN: 2078-0966 (Online)

Table-1. Results for License Plate Edge Detection

	Original Image	After Histogram Equalization [3]	After Gray Level Grouping [1]	Proposed Method
RESULT-I				
IMAGE				
EDGE MAP				
RESULT-II				
IMAGE				
EDGE MAP				

ISBN: 978-988-18210-9-6
ISSN: 2078-0958 (Print); ISSN: 2078-0966 (Online)

V. CONCLUSION

Thus a novel approach has been discussed for contrast and edge enhancement. This approach is very flexible and one can adjust the parameters (T, d, m) as per the requirement. This method has showed fairly good results for all type of ill posed images whether it is bright or dark. This method involves no complex computation but just adjusting simple parameters it can detect edges accurately Thus this method proves to be a good approach to obtain better result in the LPL domain.

REFERENCES

[1] Zhi Yu Che, Besma R. Abidi, David L. Page, and Mongi A. Abidi, “Gray-Level Grouping (GLG): An Automatic Method for Optimized Image Contrast Enhancement—Part I: The Basic Method” IEEE TRANSACTIONS ON IMAGE PROCESSING, VOL. 15, NO. 8, AUGUST 2006 W.-K. Chen, *Linear Networks and Systems* (Book style). Belmont, CA: Wadsworth, 1993, pp. 123–135.

[2] R. C. Gonzalez and R. E.Woods, *“Digital Image Processing”*, 2nd ed. Englewood Cliffs, NJ: Prentice-Hall, 2002, ISBN: 0-201-18075-8.

[3] Zhiyuan Xu, Xiaoming Liu, Na Ji “Fog Removal from Color Images using Contrast Limited Adaptive Histogram Equalization” Image and Signal Processing, 2009. CISP '09. 2nd International Congress 17-19 Oct. 2009

[4] Tarik Arici, Salih Dikbas, and Yucel Altunbasak ,“A Histogram Modification Framework and its application for image contrast enhancement” IEEE TRANSACTIONS ON IMAGE PROCESSING, VOL. 18, NO. 9, SEPTEMBER 2009

[5] Tzu-Cheng Jen, Brian Hsieh and Sheng-Jyh Wang, “Image Contrast Enhancement based on intensity-pair distribution”, IEEE International Conference on Image Processing VOL.1 Page 11-14 Sept. 2005.