Automated Car License Plate Localization using Wavelet Analysis

Nadir Charniya
Dean R and D
Lokmanya Tilak College
of Engineering, Navi Mumbai

ABSTRACT
Detection of vehicle license plate is vital for identifying the vehicle because the license plate has unique information for each vehicle. However, in India, vehicle license plate standards, though they exist, are rarely practiced. Large amount of variations are seen in the parameters of license plate like size of number plate, its location, background and foreground color, etc. which makes the task of number plate localization for recognition more difficult. This paper presents a Wavelet analysis based methodology for precise localization of Indian number plates.

Keywords
License Plate Isolation, Image Processing, Wavelet transforms, System Automation.

1. INTRODUCTION
Automated vehicle license plate location and recognition plays an important role in various applications such as, car parking lot, expressway toll collection systems, vehicle identification etc that avoids the wastage of manpower and time. Different techniques in relation to this have been proposed. However, most of them work under restricted conditions like license plates must be as per the standards of RTO, fixed illumination of the vehicle, etc. Any drift from these restrictions leads to error or failure in number plate localization and recognition. In addition to this there is serious violation of rules laid down for license plate in an Indian scenario where RTO standards for number plates are violated in many cases in order to give it a fancy look.

Different approaches have been proposed in the literature for the license plate localization. The features of license plates include shape, symmetry, height-to-width ratio, color, texture, and spatial frequency. Comparing with the other features (such as length, width, and area) of a vehicle plate, shape, texture, and color have more salient effect. Therefore, Chen *et al.* mainly analyzed these three features and computed their salience. Further, the vertical and horizontal lines of the license plate were detected by Hough transform. Wanjie [2] developed an algorithm of first difference combined with binarization to take the advantage of the horizontal texture characteristic and the physical trait in the plate area to locate the plate. Fan *et al*. [3] used Markov network to integrate segmentation and recognition of license plates. Chang *et al.* [4] proposed a license plate locating module with the aid of fuzzy logic. Nieuwoudt *et al.* [5] used region growing for segmentation. The basic idea behind region growing was to identify one or more criteria that are characteristic for the desired region. After establishing the criteria, the image was searched for any pixels that fulfill the requirements. Whenever such a pixel were encountered, its neighbors were checked, and if any of the neighbors also match the criteria, both the pixels were considered as belonging to the same region. Wanniarachchi *et al.* [6] and Pillai and Sukesh [7] experimented morphological features for detection of license plate. Morel and Solemini [8] used Partial Differential Equation and Neuro-fuzzy technique for the location of license plate. Duan *et al.* [9] used Hough transform whereas Xu and Ma [10] used Gobor filter for detection of license plate. Qudri and Asif [11] experimented on license plate background color search algorithm to extract the likelihood Region of Interest. Huang *et al.* [12] used the Gaussian filter and the power-law transformations to extract the area of license plate. These methods of license plate localization were found to work under restricted conditions like the license plates must be as per the standards of RTO, fixed illumination of the vehicle, etc. This paper proposes Wavelet analysis based license plate localization method that ratifies these problems in the existing systems.

2. LICENSE PLATE DETECTION AND ACQUISITION
An infrared outdoor day and night CCTV camera-SCR 510 with a resolution of 600 TVL has been used. The camera is interfaced with the PC using EasyCap™ the USB based video frame capturing module. The infrared sensor system detects the vehicle at the gate and then the vehicle image with its license plate is captured by the camera. Car image capturing and processing has been performed using the Matlab Image Processing Toolbox [13], Image Acquisition Toolbox [14] and Wavelet Toolbox [15].

3. LICENCE PLATE ISOLATION
Wavelets have already proven themselves to be an indispensable addition to the analyst's collection of tools and continue to enjoy a burgeoning popularity today. The plate isolation in this work has been implemented using wavelet

transform. Single-level wavelet decomposition was performed using two dimensional wavelet transform on the input image. This generates the coefficient matrices of the level-one approximation (CA1), diagonal details (CD1), horizontal details (CH1), and vertical details (CV1) respectively [15]. License plate isolation is carried out is two steps; namely a) Horizontal clipping of plate and b) Vertical clipping of plate.

Fig. 1 Vehicle Image captured by CCTV

Fig. 2 Approximate component (CA1) of the image

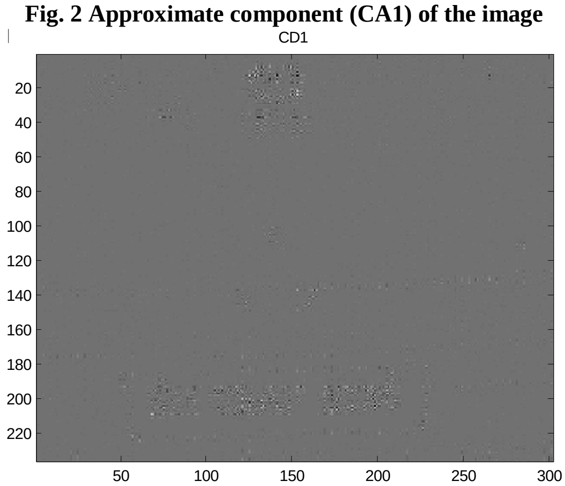

Fig. 3 Detailed component (CD1) of the image

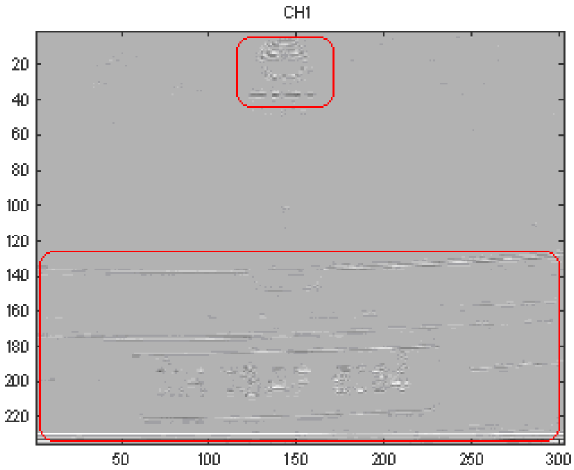

Fig. 4 Horizontal component (CH1) of the image

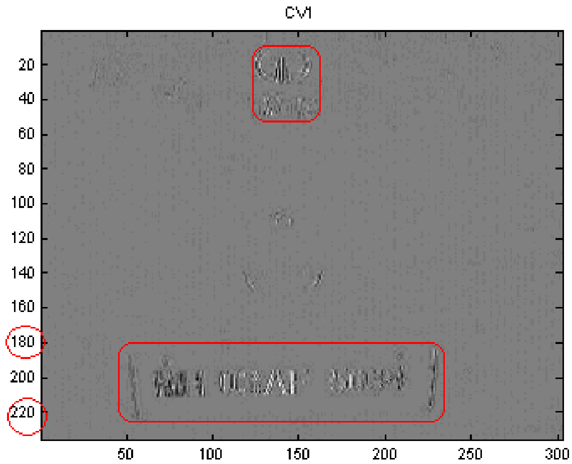

Fig. 5 Vertical component (CV1) of the image

3.1 Horizontal Clipping of Plate

The typical input image acquired by CCTV is shown in Fig. 1. The input colored image is converted to grey image which is two dimensional and easy to analyze. The grey image is then decomposed into four Wavelet components viz. CA1, CH1, CV1, and CD1 shown in Figs. 2-5 for feature extraction. From these set of components it has been found that CV1 (Fig. 5) gives dominant energy feature for isolating horizontal clip of the license plate. From number of trials it is found that Daubauchis order 5 worked reasonably well for feature extraction. The indexed image CV1 shows that index 180 to 220 on y-axis is the region where the horizontal clip of plate lies. The normalized energy signal of y-component of CV1 is obtained that is found to be suitable for horizontal clipping. The number plate being high frequency area shows peak in the energy signal along y-axis from index 180 to 220 approximately. The peak of energy signal is clipped by setting normalized threshold energy value of 0.5. This threshold was decided after conducting trials on different plates for horizontal clipping. The thresolded signal (Fig. 6) gives the index 186 to 221 on y-axis where the horizontal clip of the plate is located. The CA1 is clipped for the index 186 to 221 on y-axis to obtain the horizontal clip as shown in Fig. 7. From the horizontal clip of CA1 the horizontal clip of original image is reconstructed as depicted in Fig. 8. The indices of the original image are double of the index of it components [15].

3.2 Vertical Clipping of Plate

The procedure for vertical clipping is similar to horizontal clipping. The horizontal clip shown in Fig. 8 is decomposed into four Wavelet components viz. approximation (CA11), horizontal (CH11), vertical (CV11) and diagonal (CD11) shown in Fig 9-12 for feature extraction. From these set of components it has been investigated that CV11 (Fig. 12) gives dominant energy feature for isolating vertical clip of the license plate. From number of trials it was found that Daubauchis with order 2 worked reasonably well for the feature extraction. By observing the indexed image of CV11 it is found that the index 50 to 230 approximately, on x-axis is the region where the vertical clip of the plate lies. Here, the normalized energy signal (Fig. 13) from x-component of CV11 is obtained that is found suitable for vertical clipping. The energy signal shows peaks from *X*-index 52 to 228 i.e. the start and end points of the energy signal. The energy signal between start and end point gives the exact region where the vertical clip of the plate lies. Hence, CA11 is clipped from the *X*-index 52 to 228 to obtain the vertical clip. From the vertical clip of CA11 the vertical clip of original image is obtained as shown in Fig. 14. This reconstructed image of the license plate is converted to negative binary image Fig. 15. Thus, the plate has been isolated precisely from the vehicle image. The binary image of the isolated plate can be easily used further to recognize the numbers on the plate.

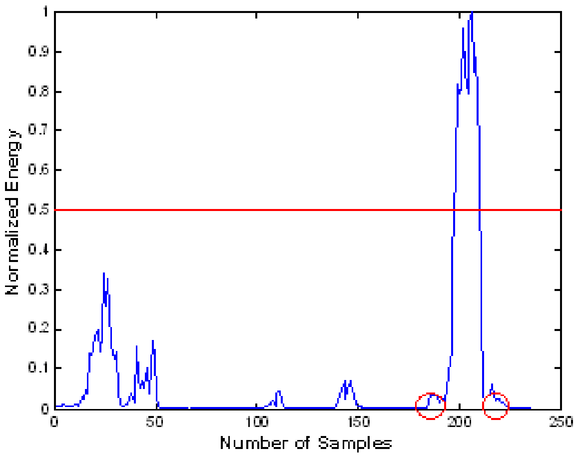

Fig. 6 Normalized energy signal from y-component of CV1

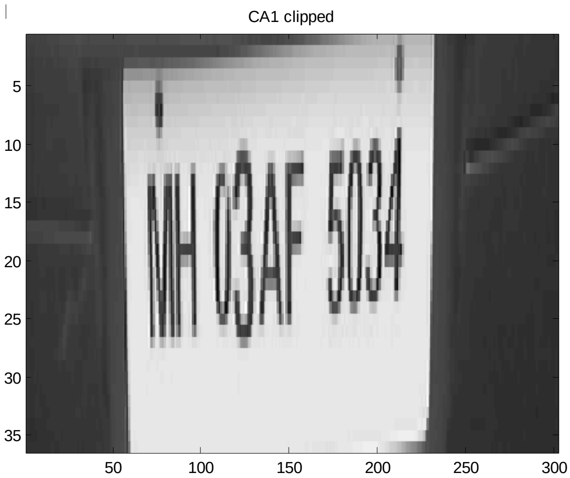

Fig. 7 Horizontal clip from CA1

Fig. 8 Horizontal clip reconstructed from original image

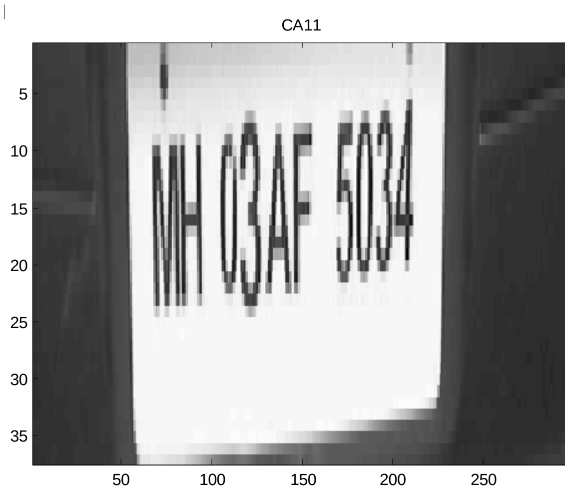

Fig. 9 Approximate component (CA11) of the horizontal clip

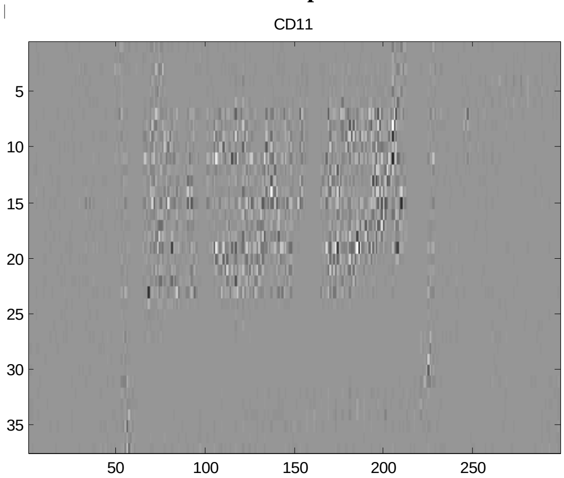

Fig. 10 Detailed component (CD11) of the horizontal clip

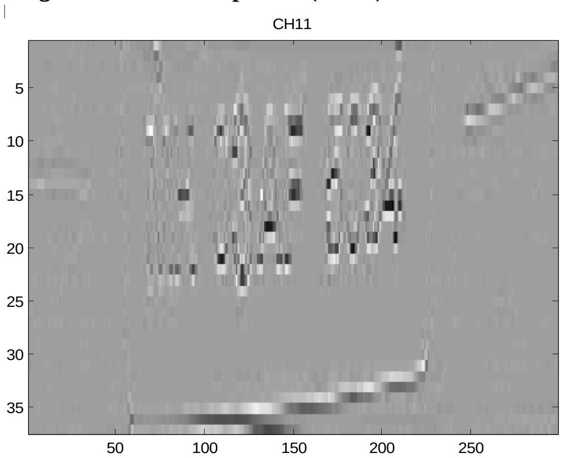

Fig. 11 Horizontal component (CH11) of the horizontal clip

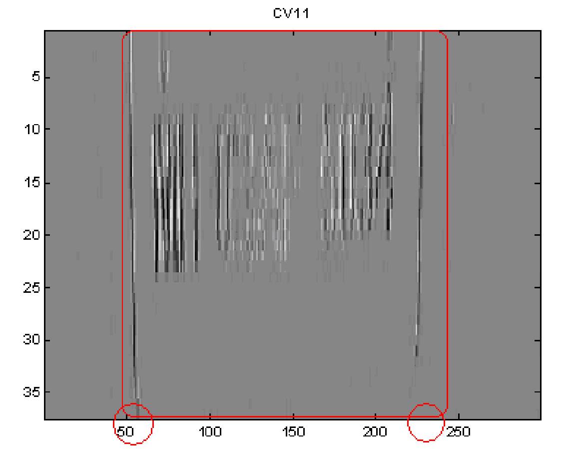

Fig. 12 Vertical component (CV11) of the horizontal clip

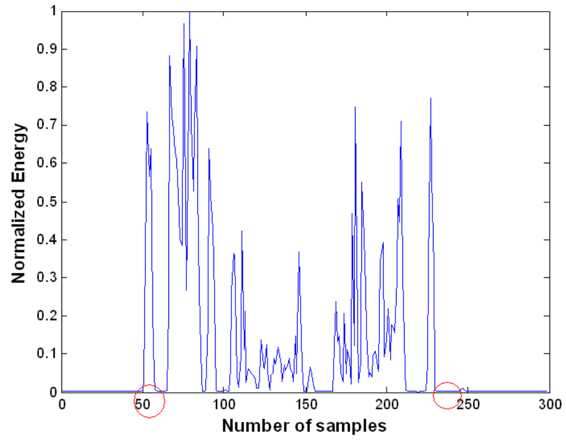

Fig. 13 Normalized energy signal from x-component of CV11

Fig. 14 Vertical clip reconstructed from original image

Fig. 15 Binary image of the isolated plate

4. CONCLUSION

The vehicle license plate isolation is always difficult due to the variable size, shape, pose, and lighting condition in the image. The background color may be very similar to that of vehicle license plate and the image may contain a number of noises.

This work was investigated experimentally on seventy different challenging car images using prototype parking system. The results show that the system robustly locates license plate against different lightening conditions. The algorithm satisfactorily eliminates all the background noise and preserves only the number plate area in the image.

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6. REFERENCES

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