



Recognition of Car License Plate using Morphology

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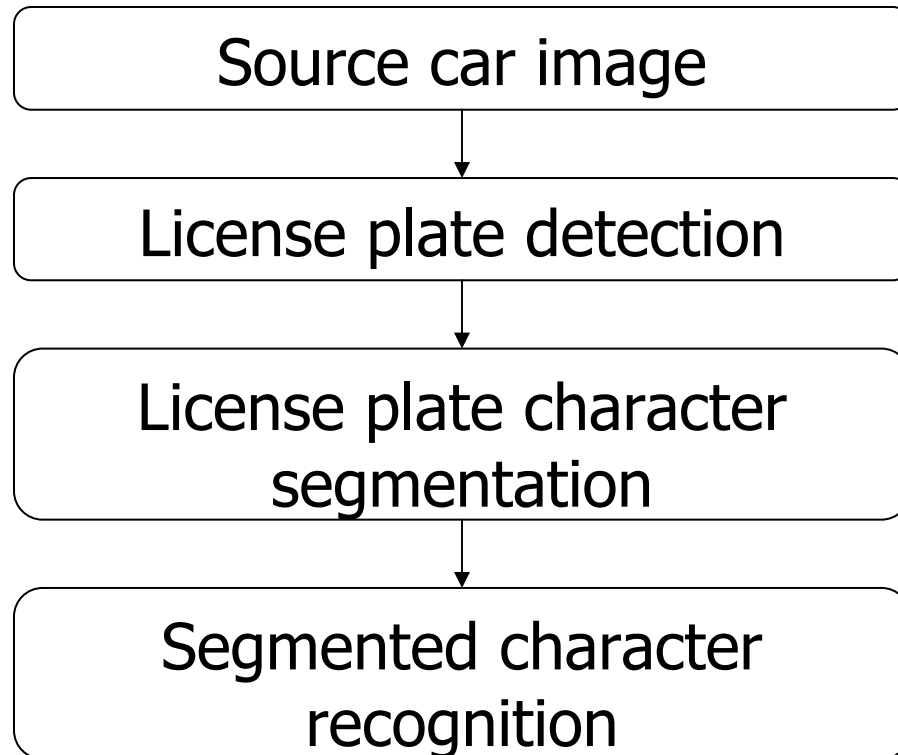
Outline

- Motivation
- Problem Overview
- License plate segmentation
- Character segmentation
- Character Recognition
- Results and discussions
- Conclusion

Motivation

- Automatic license plate recognition could be used to automatically open a gate or barrier into a secured area for authorised members. This could replace or assist security guards at the gates or barriers of premises.
- If a vehicle is stolen, it could be marked in the license plate recognition system as so. If at any point the stolen vehicle happens to pass a camera on the roadside that belongs to the license plate recognition system an alarm is set off to alert a guard.
- To control the Traffic flow management.

Problem Overview



Demo



LP Detection

Recognition J V 5 0 5 2



License Plate Detection

- Vertical edge detection
- Morphological operations
- Connected component analysis

Character Segmentation

Skew correction

- Hough transform method is the simple way to determine the tilting angle for the plate.
- In the ρ - θ plane of license plate image, the angle at which accumulator cell shows maximum value is becomes the skew of image.



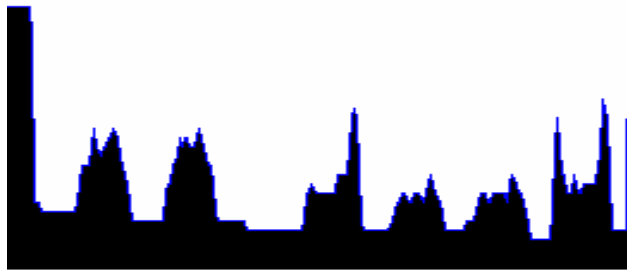
Segmented plate (tilted)



Corrected image (tilt angle 1.1°)

Projections on Binary image

The isolation of the license plate from any superfluous background is performed using a histogram that reflects the number of black pixels in each row and in each column.



Horizontal projection



Binarized image



Vertical projection



Segmentation of characters

Character Recognition

- Template matching is one of the most common and easy classification methods for recognizing the characters.
- Size of character images are same as the templates and each pixel in the extracted character image from the license plate is compared to its corresponding pixel in the template.
- Segmented character images are scaled to size of the templates using bilinear interpolation prior to matching.
- Constructing Database of templates.

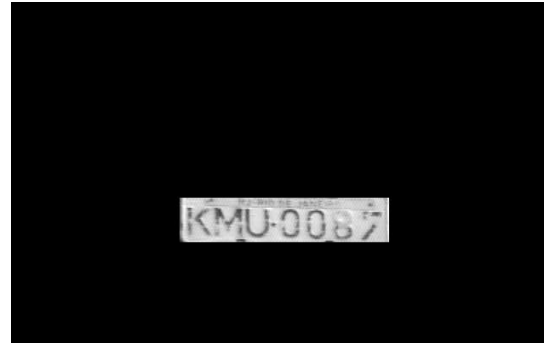
Results

License Plate Segmentation

(1)



(2)



Car images on left containing obscured license plates and segmented license plates on right

(3)



(4)

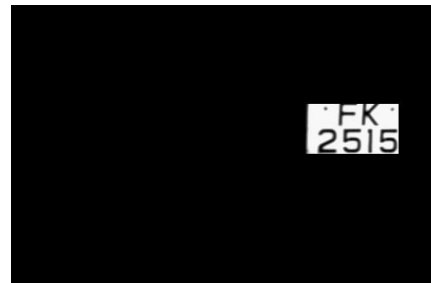


Car images on left containing texture like road and segmented license plates on right side

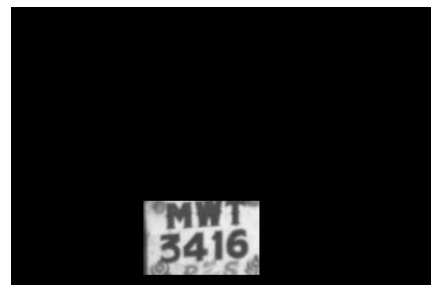
(5)



(6)



(7)



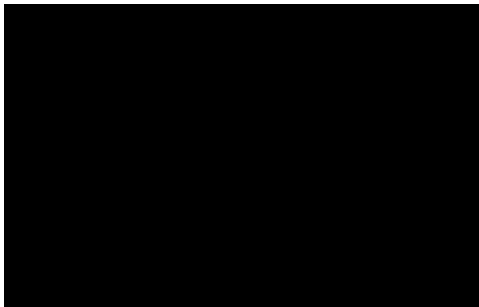
Car images on left containing brand names along with license plates and segmented license plates on right

Comparion with an existing technique[4] method

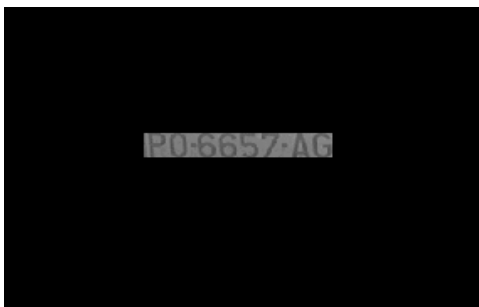
[4] F. Martín, M. García and J.L. Alba, "New Methods for Automatic Reading of VLP's," *In proceedings of IASTED International conference on Signal Processing, Pattern Recognition, and Applications (SPPRA)*, 2002.



(a) Source car images



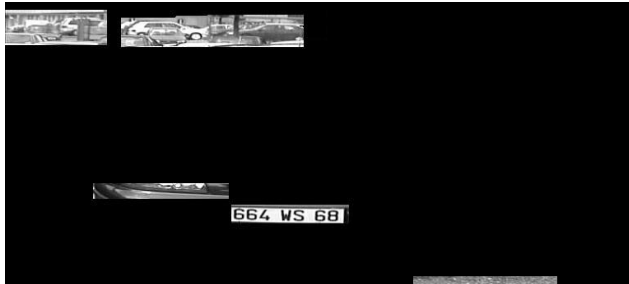
(b) License plate segmentation [4]



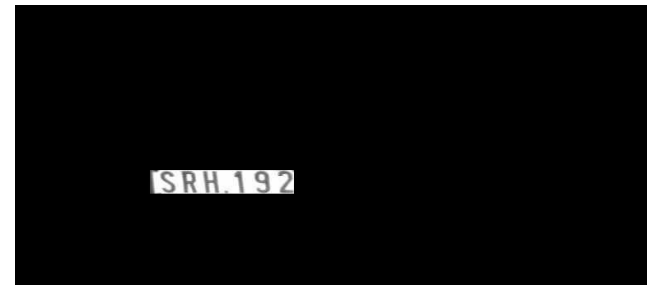
(c) License plate segmentation by proposed method



(a) Source car images



(b) License plate segmentation by Martin's method



(c) License plate segmentation by proposed method

Discussions

- Images containing texture and background objects.
- Presence of regular structure called bumper near (above/below) the license plate, which is same dimension as license plate,
- If the lighting conditions are not fair enough, performing binarization after morphological top-hat operations leads to loss of characters from the license plate.
- Few car images also consist of brand names, captions and other symbols in addition to license plates, which are difficult cases for segmentation.

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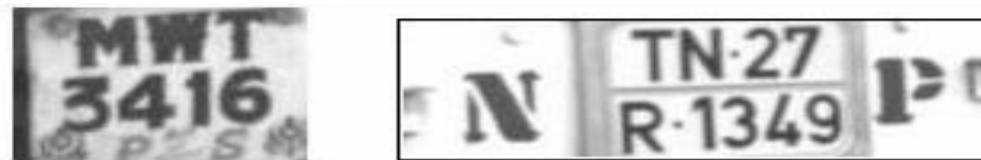
Recognized plates



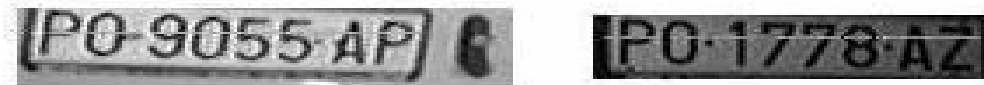
(a) Inseparability of characters from background texture



(b) Obscured license plates



(c) Presence of special symbols on plates



(d) Scratches on plates causes character breaking

License plates failed in recognition

Accuracy of LPR

Country	Database size	Extracted license plates	Test data size	Recognized license plates
Hong Kong	25	25	41	38
China	31	31	50	44
India	19	19	29	26
Europe	54	54	74	65
South Africa	19	19	28	25
Brazil	75	75	102	85
Spain	98	98	145	127

Test set 1	Test set 2	Test set 3
86.25%	90.62 %	88.75%



Conclusion

- Detection works for complex environments like low illumination, image containing multiple background objects, texture and brand names.
- Accuracy of LP detection is 100% for country wise parameters and 95% for global case.
- LP Recognition accuracy on average from test sets is 88.54%.
- Features like character height, spacing, LP height and width are used for LP detection.

References

- [1] Y. Yanamura, et al, "Extraction and Tracking of the License Plate using Hough Transform and Voted Block Matching," *In proceedings of IEEE Intelligent Vehicles Symposium*, 2003, pp. 243 - 246.
- [2] K. Yamaguchi et al, "A Method for Identifying Specific Vehicles using Template Matching," *proceeding of Intelligent Transportation Systems*, Japan, 1999, pp. 8-13.
- [3] H. Hansen, A.W. Kristensen, M.P. Kohler, A.W. Mikkelsen, J.M. Pedersen and M. Trangeled, "Automatic Recognition of Number Plates," Institute of Electronic Systems, Aalborg University.
- [4] F. Martín, M. García and J.L. Alba, "New Methods for Automatic Reading of VLP's," *In proceedings of IASTED International conference on Signal Processing, Pattern Recognition, and Applications (SPPRA)*, 2002.
- [5] R.C. Gonzalez, R.E. Woods, *Digital Image Processing*, Addison-Wesley, 1993.
- [6] J. Serra, *Image Analysis and Mathematical Morphology*, Academic Press, London, 1982.
- [7] R. Haralik, L. Shapiro, *Computer and Robot Vision*, Addison-Wesley publishing company, 1993.
- [8] N. Otsu, "A threshold selection method from gray-level histograms," vol. SMC-8, *IEEE Transactions on Systems, Man, and Cybernetics*, 1979, pp. 62–66.
- [9] Remus Brad, "License Plate Recognition System," *Proceedings of the 3rd International Conference on Information, Communications and Signal Processing*, Singapore, 2001.



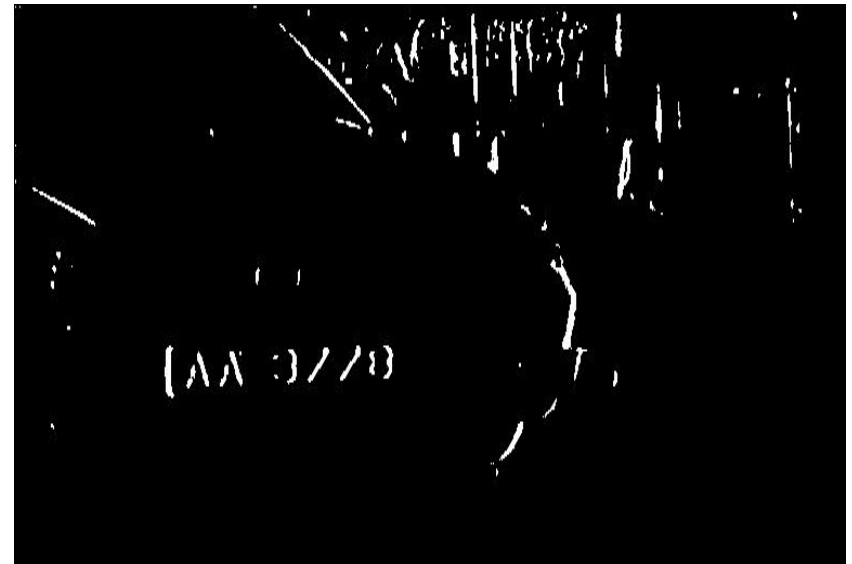
Thank you

- The presence of vertical edges in license plate is more likely compared to the presence of horizontal edges in the same region.
- Suitable threshold is computed using the well-known Otsu's method [8] that is based on gray-level histogram analysis. The advantage of this method is that the threshold value is adaptively determined from each car image.

$$\begin{array}{ccc}
 \left| \begin{array}{ccc} -1 & -2 & -1 \\ 0 & 0 & 0 \\ 1 & 2 & 1 \end{array} \right| & & \left| \begin{array}{ccc} -1 & 0 & 1 \\ -2 & 0 & 2 \\ -1 & 0 & 1 \end{array} \right| \\
 \text{Gx} & \text{Sobel Masks} & \text{Gy}
 \end{array}$$



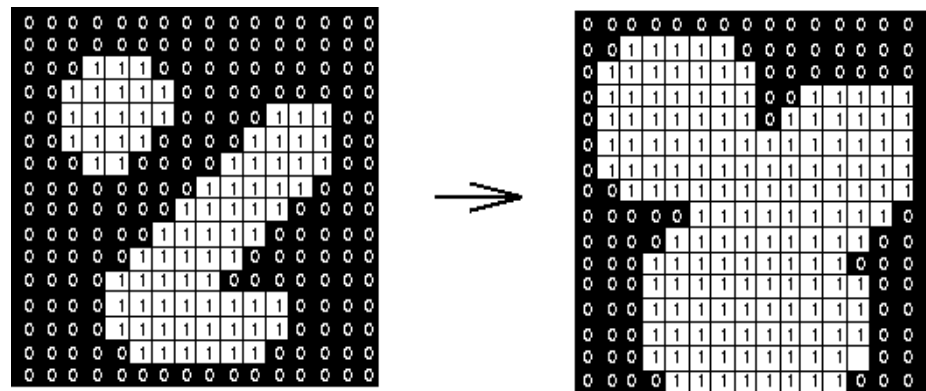
Source Car Image



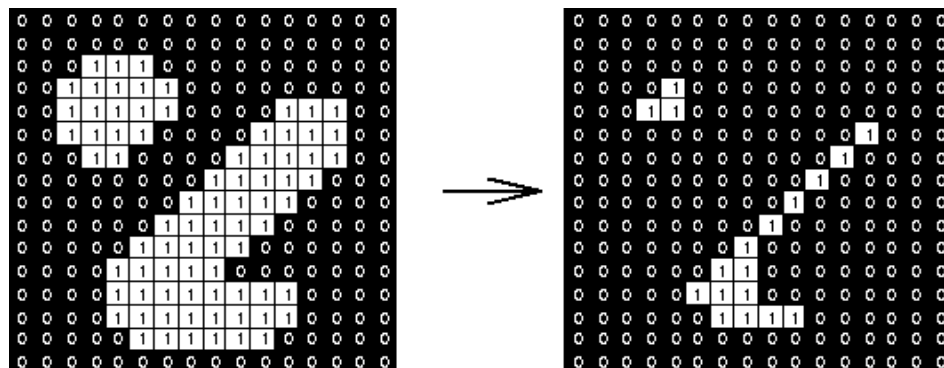
Edge Image

Basics of morphology

- Erosion is often used to remove irrelevant details from binary image and dilation is used to fill the gaps or holes.
- Opening generally smoothes the contour of an object, breaks narrow isthmuses, and eliminates thin protrusions.
- Closing also tends to smooth sections of contours but as opposed to opening, it fuses narrow breaks and fills gaps in the contour.



Dilation example



Erosion example

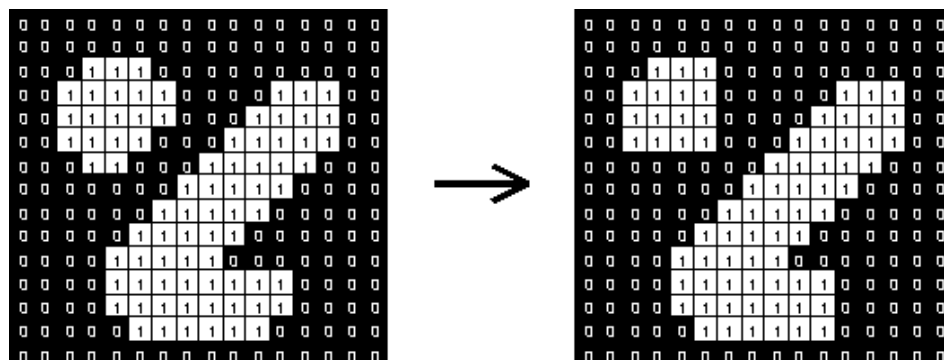


Image opening

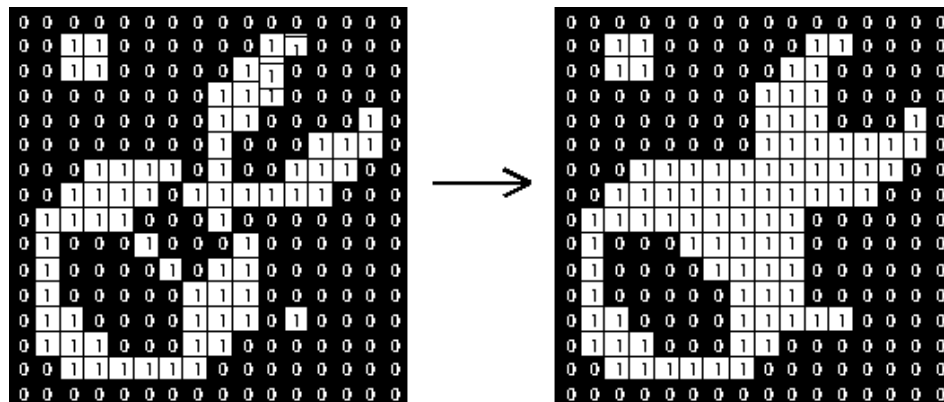
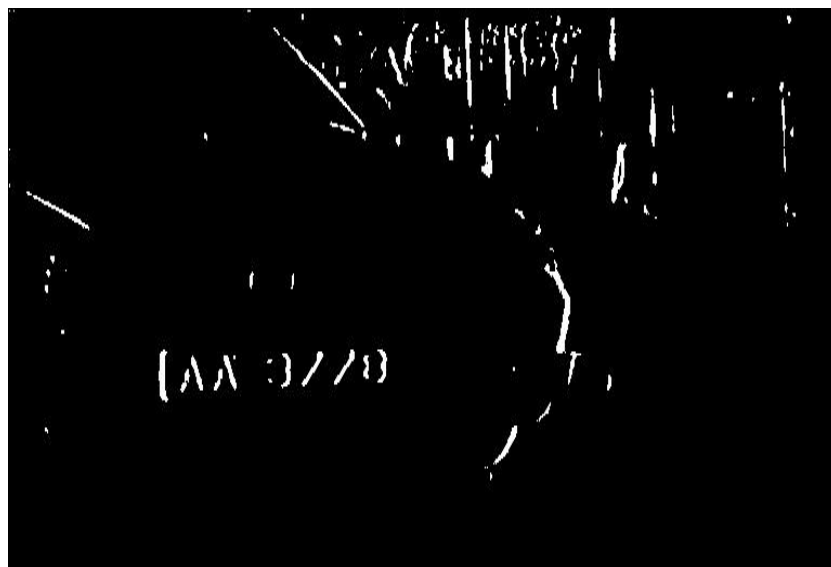
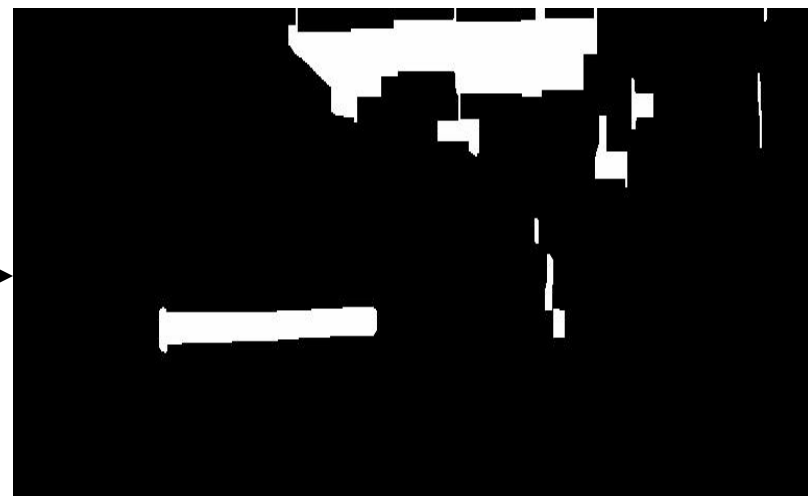


Image closing

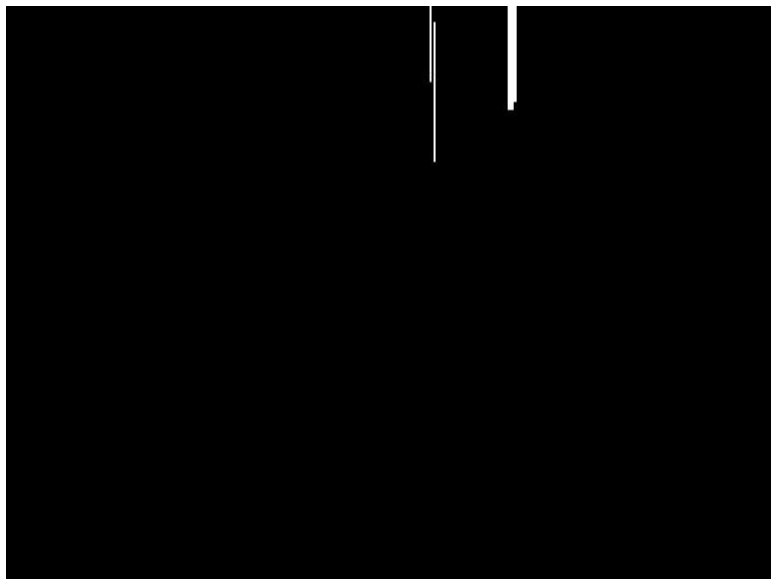
Sequence of Morphological operations performed on edge image



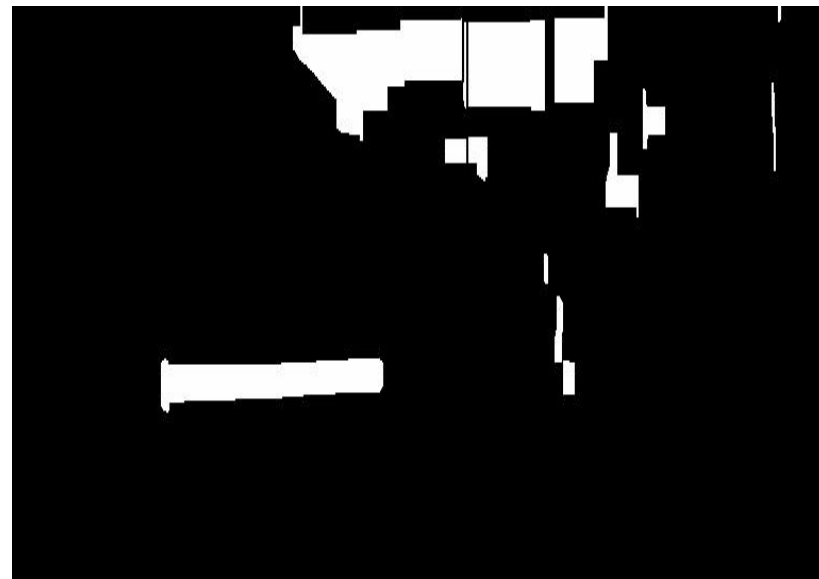
Closing operation performed to fill the gap between characters



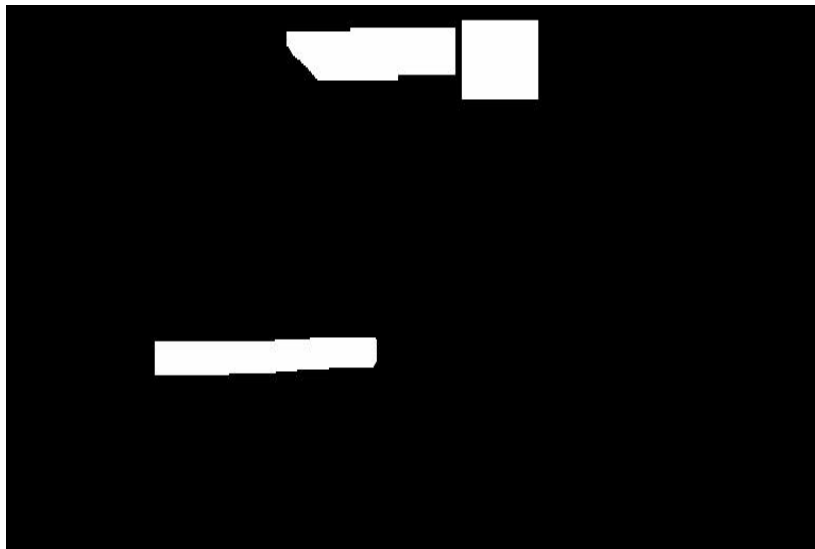
Regions whose height less than minimum character height are eliminated using Opening operation



Detecting regions with height greater than maximum plate height
(image opening)



Removal of taller noise blobs
(image opening)

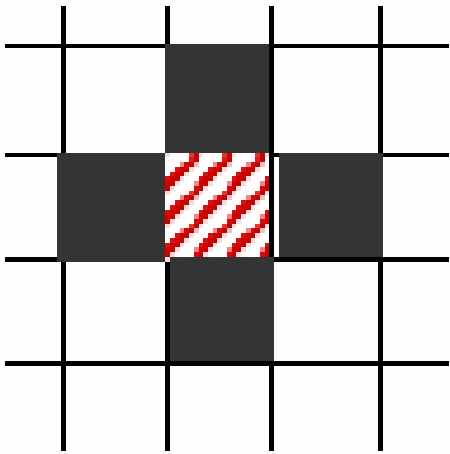


Regions left after morphological operations

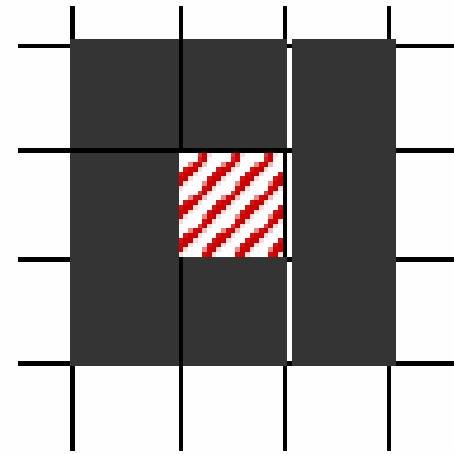


Regions left from original car image

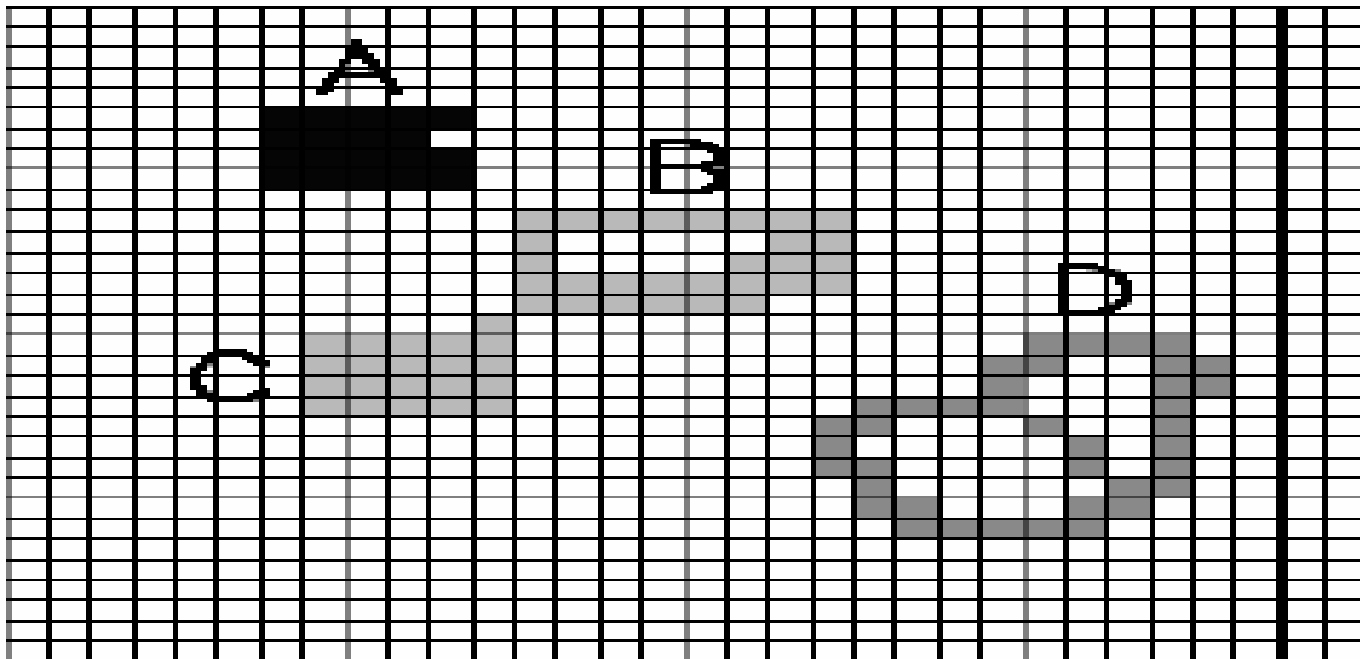
Connected Component Analysis



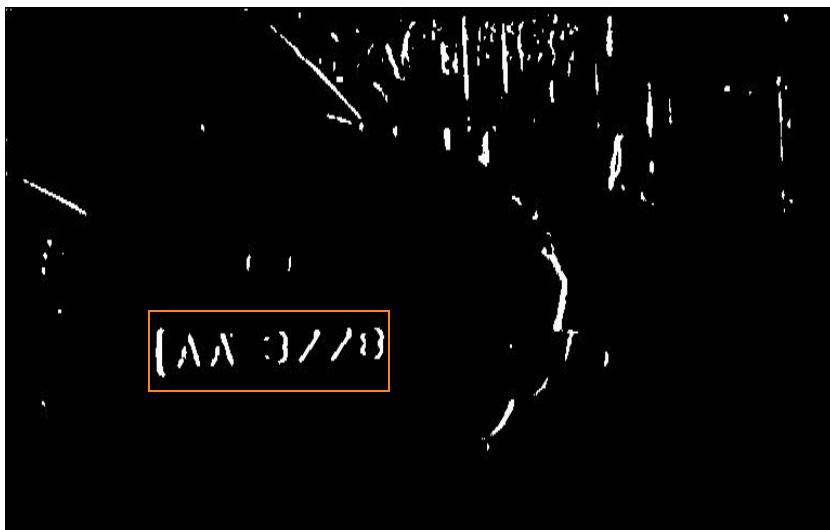
4-neighbourhood



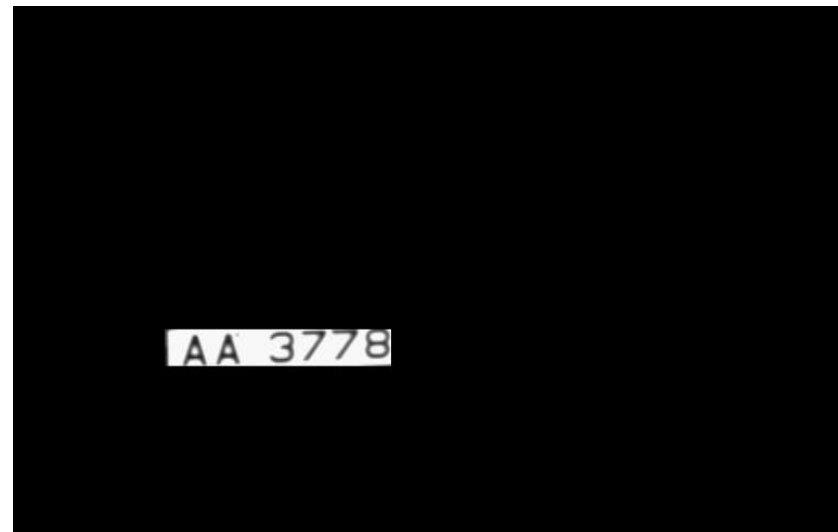
8-neighbourhood



Component labeling



Edges of car image



Final detected plate

