Indonesian Vehicle Plate Recognition and Identification Based on Digital Image Processing and Artificial Neural Network

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ABSTRACT
Every vehicle has its own license which is given legally. In Indonesia, vehicle registration number is an important thing used by system such as: parking system, building security system and toll system.

This research is doing a vehicle plate recognition and identification which will read the characters on the plate. The input comes from a real time video. There are six main processes in this system. In preprocessing, the system will enhance frame by using top hat and bottom hat transformation. While in detection, it will detect and crop the plate by using integral protection. After getting the plate position, an identification process will do by doing segmentation in each character. Then a feature extraction which combined with Artificial Neural Network is done to get the character of the vehicle registration number.

Keywords
Vehicle Registration Number, Self Organizing Maps

1. INTRODUCTION
Every vehicle has its own identities; one of them is a plate with vehicle registration number. The identity mostly used in parking system, building security system and toll system. In order to make the system reliable, it is needed to develop an automatic system which can recognize and identify the vehicle registration number.

Every nation has their own license plate standard and it's different between one and another. For Indonesia, standard of license plate is black background with white character. Several research to detecting and extracting plate are using bounding box method [11] or Hough transform [6] that detect the line of background plate to know where the plate is, but those kind of methods will fail when it's used for detecting and extracting Indonesian license plate from a black car.

This research proposes combination method to detect and extract license plate that suitable for Indonesian license plate. And for the accuracy adjustment the system divide the plate into three parts: the first and the third plate are alphabet, and the second plate is number. By doing this, the identifying between alphabet and number are done separately and this method will reduce the possibility of wrong detection between the similar pattern of alphabet and number such as O and 0.

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The main objective of this research is to develop a system that can detect and identify the number of from vehicle registration plate.

2. SYSTEM DESIGN

2.1 VIDEO INPUT
The input comes from a video got from a digital camera with 640x480 pixel using *.avi format. Then an extraction has done by arranging the frame as a digital image.

2.2 PREPROCESSING
Each frame from extraction is processed independently. RGB conversion to grayscale, frame cutting, top-hat and bottom-hat transformations. Frame cutting is done with an assumption that the vehicle plate is on the lower location of the frame.

Top-hat and bottom-hat transformation is a transformation based on mathematic morphology. This transformation will expand the grey region so that the region which the vehicle plate located will clearly visible.

Figure 1: RGB image

2.3 PLATE DETECTION

After preprocessing, an edge detection and low pass filtering is done to eliminate the noise in the image. The detection of the vehicle plate is done by using integral projection method. This method is capable to find the region of the object by adding the pixel each row and column.

The plate region has more pixel than the other region. The threshold value is the average number of pixel from the image from edge detection process.

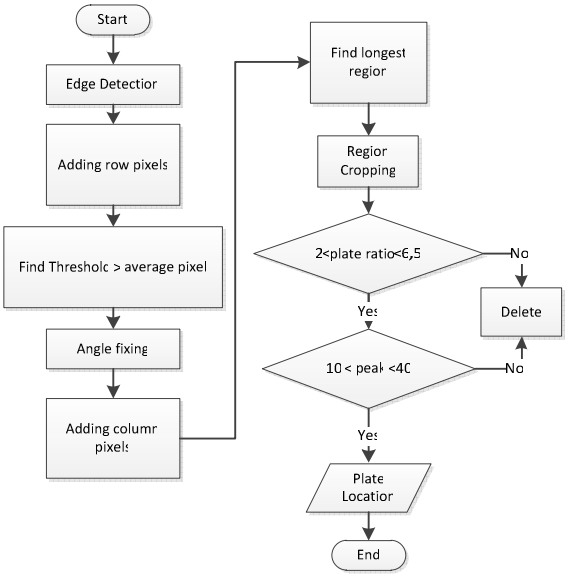

Figure 2: Plate Detection Flowchart

2.4 SEGMENTATION AND NORMALISATION

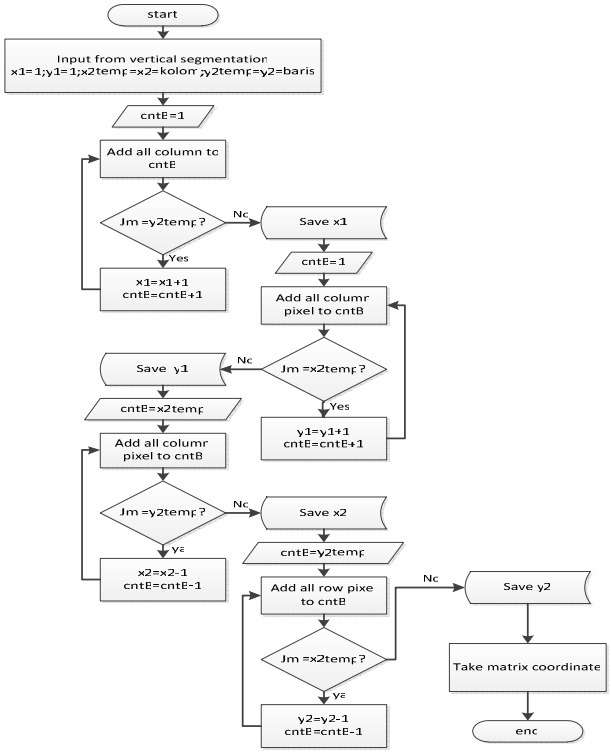

Figure 3: Edge segmentation

Based on the characteristic of the vehicle plate in Indonesia, the region of the characters is divided into three parts. This is done in order to increase the accuracy of the character recognition.

There are three segmentations done in this process, horizontal segmentation, vertical segmentation and edge segmentation. Basically the horizontal and vertical segmentation are similar, the different is in the iteration process. In horizontal segmentation, iteration is done from the first row, while in vertical segmentation the iteration is done from the first column.

Edge segmentation algorithm:

1. Inverse the image's color from vertical segmentation.
2. Adding row pixels into one column.
3. while total pixel = total row, do next column iteration; while total pixel = total row stop iteration
4. Save coordinate, repeat step 2 and 3.

2.5 FEATURE EXTRACTION

Feature extraction used in this research is vector based feature extraction. Each 8x8 pixels matrix average is being calculate then obtained a 1x8 pixels. The average pixels are done by summed every 8x8 pixels.

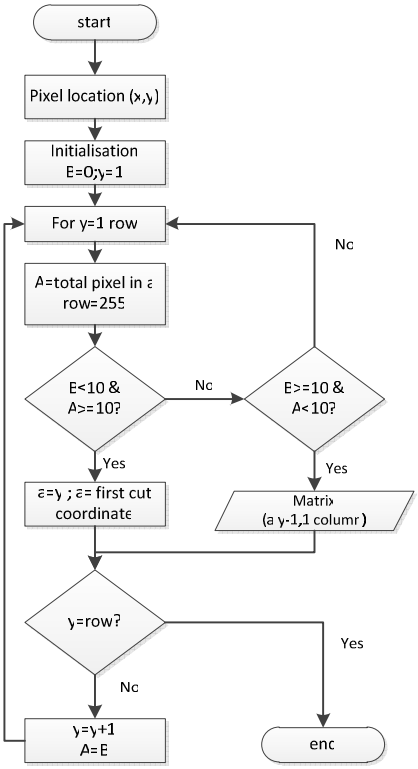

Figure 4: Horizontal Segmentation

2.6 Character Recognition using Self Organizing Maps

The input of this process comes from feature vectors of each character. The output this process are 26 classes of character and 10 classes of number. Because the input vector's size is 1x8 matrixes, the neural network build eight neuron input.

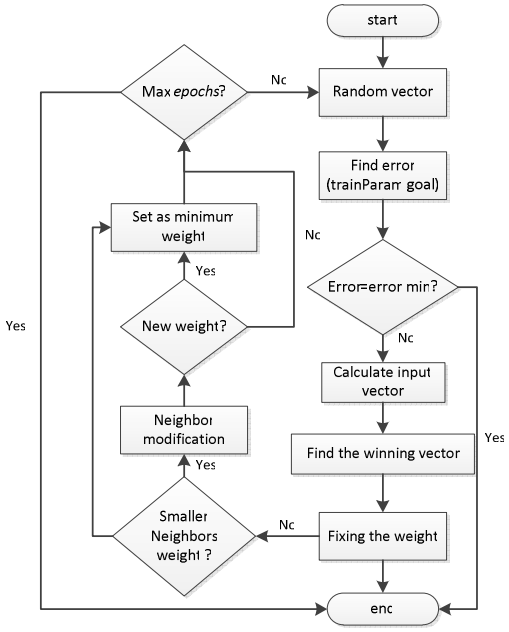

Figure 5: Self Organizing Maps

Self-organizing maps (SOM) learn to classify input vectors according to how they are grouped in the input space. They differ from competitive layers in that neighboring neurons in the self-organizing map learn to recognize neighboring sections of the input space. Thus, self-organizing maps learn both the distribution (as do competitive layers) and topology of the input vectors they are trained on.

The neurons in the layer of an SOM are arranged originally in physical positions according to a topology function. The function gridtop, hextop, or randtop can arrange the neurons in a grid, hexagonal, or random topology. Distances between neurons are calculated from their positions with a distance function. There are four distance functions, Euclidean distance, box distance, link distance, and Manhattan distance.

$$dj = \sum_{i=0}^{n-1} (xi(t) - wij(t))^2$$

In learning process, the input is an 8x26 matrix for character and 8x9 for number. Every character is got from the feature extraction method. The matrix is ordered in a row so that the final matrix is 28x8 and 9x8. Next step is transposing the matrix into 8x26 and 8x9 as input to neural network. The transpose is done because the class of the neural network is done by column.

2.7 System Testing

The testing is done for each different parameter of SOM neural network. So, analysis of the accuration can be done by seeing the effect of each parameter. Systematically the calculation of the accuration can be written as:

$$Accurations = \frac{total\_correct\_result}{total\_data} x100\%$$

3. EXPERIMENT RESULT

Experiments have been performed to test the proposed system.

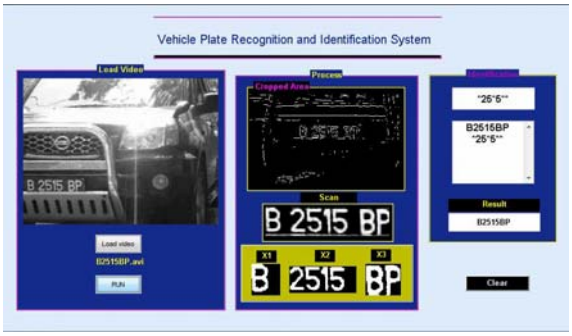

Figure 6: User Interface

Table 1: Character identification

Topology	Distance Function	Total character	Correct character	Missed character	Accuration
Gridtop	Dist	137	119	18	86,86%
	mandist	137	122	15	89,05%
	linkdist	137	120	17	87,59%
	boxdist	137	121	16	88,32%
Hextop	dist	137	121	16	88,32%
	mandist	137	118	19	86,13%
	linkdist	137	122	15	89,05%
	boxdist	137	134	3	97,81%
Randtop	dist	137	120	17	87,59%
	mandist	137	122	15	89,05%
	linkdist	137	119	18	86,86%
	boxdist	137	117	20	85,40%

From table 1 can be seen that the best accuration of the detection using combination of the hexagonal topology and box distance function. The accuration is 97,81%.

Figure 7: Image output from edge detection

Table 2: Distance function testing

Topologi	*Epochs*	*Learning Rate* (α)	Fungsi Jenis *Distance*	Accuration
Gridtop	200	0.9	*Linkdist*	87.35%
Hextop	200	0.9		76.82%
Randtop	200	0.9		80.92%
Gridtop	200	0.9	*Dist*	86.67%
Hextop	200	0.9		86.34%
Randtop	200	0.9		85.36%
Gridtop	200	0.9	*Mandist*	81.16%
Hextop	200	0.9		88.30%
Randtop	200	0.9		85.09%
Gridtop	200	0.9	*Boxdist*	83.42%
Hextop	200	0.9		89.23%
Randtop	200	0.9		86.67%

By using the different pairs of topology and function distance, the system can be obtained the different result. The system is tested by using 20 videos that contain license plate and complex background which is taken around 08.00 – 11.00 am.

Figure 8: Plate Cropping

From the result in table 1, it can be concluded that the best result is by using hextop topology and boxdist for the distance function. While in general identification, there are 3 mistakes that made from 20 input.

4. CONCLUSION

The proposed system for the detecting and extracting plate is reliable for the 20 video testing which is has complex background and the system can detect the plate even though there are no assumptions of distance between plate and camera.

The best accuracy for character identification is obtained by using hexagonal topology and box distance with 97, 81 % in average.

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