A Position-Varied Plate Utilized for A Thai License Plate Recognition

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Abstract—This paper presents a position-varied plate utilized for Thai license plate recognition using back propagation neural network (BPNN). In this method, a dimension image of the car is suitably decreased by image resizing (e.g. interpolation method), and then they are converted to gray images for inputs to plate localization process. The plate localization process is used to find the area position of the license plate for inputting to image segmentation process which is used to find edges of main characters in the license plate. After that, each of image characters received from character segmentation process is inserted into neural network to analyze the probable characters and numbers. In this experiment, the images of numbers and Thai characters are cross-validated by BPNN (training, validation and testing sets), and then 100 images of Thai license plate are used for testing. The results reveal that an accuracy of analysis is at approximately 97% for the distance of the car and camera between 0.5m to 1m, and the angle of inclined plate varied from ±13 degrees.

Keywords-license plate; recognition; backpropagation neural network; Thai characters

I. INTRODUCTION (HEADING 1)

Nowadays, license plate recognition (LPR) system has an important role in numerous applications, such as parking accounting systems, traffic law enforcement, road monitoring and security systems. Generally, many researches have presented the LPR focusing on their countries, for examples, Korean [1], Saudi Arabian [2], Maco [3], Portuguese [4], Thai [5-6], Arabic [7], Malaysian [8], Chinese [9], etc. Such researches have proposed several techniques such as morphological operations, a projection searching algorithm for the extraction of license plates, a character recognition based on template matching, the hierarchical cross-correlation ARTMAP, feature extraction using vertical line counter, the hybrid fuzzy technique etc. However, they have not been mentioned to the varied positions of license plate (e.g. distances between the camera and license plate, as well as, the angle of inclined plate) because it still is a big problem of the LPR system.

In this paper, a position-varied plate is utilized for Thai license plate recognition using back propagation neural network (BPNN). In this method, a dimension image of the car is suitably decreased by image resizing (e.g. interpolation method), and then they are converted to gray images for inputs to plate localization process. The plate localization process is used to find the area position of the license plate for inputting to image segmentation process which is used to find edges of main characters in the license plate. After that, each of image characters received from character segmentation process is inserted into neural network to analyze the probable characters and numbers. In this experiment, the images of numbers and Thai characters are cross-validated by BPNN (training, validation and testing sets), and then 100 images of Thai license plate are used for testing. The results reveal that an accuracy of analysis is at approximately 97% for the distance of the car and camera between 0.5m to 1m, and the angle of the inclined plate varied from ±13 degrees.

II. METHODOLOGY

Figure 1 shows overall processes for proposing the Thai LPR utilized for the position-varied plate. There are three main processes as follows. The first process is the plate localization. The second process is segmentation of numbers and characters including the position-varied plate. The third process is the recognition using neural network. The details of such three processes can be described as follows.

Figure 1. Overall process for proposing the position-varied plate utilized for Thai LPR.
A. Plate Localization

1) Converting RGB to Gray image

Figure 2 shows the image result of gray color. It is converted from the color image. The equation can be defined as [10]

\[ \text{GRAY} = (0.2989 \times R) + (0.5870 \times G) + (0.1140 \times B) \quad (1) \]

where GRAY is the results of gray color, R is a red color, G is a green color and B is a blue color.

![Figure 2. The image result of gray color.](image1)

2) Vertical Edge Detection

Figure 3 shows the image result of vertical edge detection using vertical mask of Sobel operator [11].

![Figure 3. The image result of vertical edge detection.](image2)

3) Dilation, Opening and Erosion

Figure 4 shows the image result of plate region using dilation, opening and erosion methods [11].

![Figure 4. The image result of plate region.](image3)

4) Probable Location of License Plate

Figure 5 shows the image result of probable location of license plate. The method uses the multiply of pixel per pixel between Fig. 2 (gray image) and Fig. 4.

![Figure 5. The image result of probable location of license plate.](image4)

5) Converting Gray to Binary Image

Figure 6 shows the image result of binary image converted from gray image from Fig. 5.

![Figure 6. The image result of binary image converted from gray image from Fig. 5.](image5)

B. Segmentation of Numbers and Characters Including the Position-Varied Plate

This process is segmentation of numbers and characters which can be described as follows.

1) Finding the Edge of License Plate Register

As a result from Fig. 6, the first step is to find the top and bottom edges of the register of numbers and Thai characters using histogram projection of their register along Y axis. The second step is to find the left and right edges of the register of the numbers and Thai characters using the histogram projection of their register along X axis. Figure 7 shows the image result of the edges of license plate register.

![Figure 7. The image result of the edges of license plate register.](image6)

2) Cutting the numbers and Thai characters

As a result from Fig. 7, the register of the numbers and Thai character are cut by the histogram projection of each number and character along X axis. Figure 8 shows the image results of cutting the numbers and Thai characters. Such image results are normalized for the image size as 40x80 (or equal to 3200 pixels) for width and height. Finally, they are inputted to the neural network.
3) Numbers and Thai characters of the Position-Varied Plate

As a result from Step 3), we also prepare image samples of the numbers and Thai characters which are varied from the license plate as follows:

i) The length between the license plate and camera
ii) The inclined angles of the license plate.

Therefore, such image samples are inputted to the neural network for training and testing.

C. Recognition using Backpropagation Neural Network

This part is recognition for the register of the numbers and Thai characters using backpropagation neural network (BPNN) [12] which exploits the cross validation for evaluating the performances of this proposed method. Such the cross validation consists of training (80%), validation (10%) and testing (10%) sets. The BPNN structure is designed as 3 layers i.e. 3201 nodes of input layer including bias 1 node, 100 nodes of hidden layer and 54 nodes of output layer, as shown in Fig. 9. In this proposed method, we use 10 numbers (0,1,…,8,9) and 44 Thai characters ( saturation) for training the NN (50 images per each number and also 50 images per each Thai character). Figure 10 shows an application program of graphic user interface (GUI) for this proposed method.

![Figure 9. Three layer of the neural network structure.](image)

### III. EXPERIMENTAL RESULTS

In this experiment, we use 100 sample images of Thai license plate for testing this method. Table I shows the testing results of the proposed method. As shown in Table I, the results show that the overall accuracy of analysis is at approximately 97 % for the distance of the car and camera between 0.5m to 1m, and the inclined plate varied from ±13 degree. It can be seen from Table I that if the distance and angle are more than 1.5 m and not in the range of ±13 degree, respectively, then all results are not correctly.

<table>
<thead>
<tr>
<th>Distance (meters)</th>
<th>Angle (degrees)</th>
<th>Number of Tested Images</th>
<th>Number of Corrected Images</th>
<th>Percents of Accuracy (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.5</td>
<td>±13</td>
<td>60</td>
<td>57</td>
<td>95</td>
</tr>
<tr>
<td>1</td>
<td>±13</td>
<td>40</td>
<td>40</td>
<td>100</td>
</tr>
<tr>
<td>Total</td>
<td></td>
<td>100</td>
<td>97</td>
<td>97</td>
</tr>
<tr>
<td>&gt; 1.5</td>
<td>not in the range of ±13</td>
<td>5</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Total</td>
<td></td>
<td>5</td>
<td>0</td>
<td>0</td>
</tr>
</tbody>
</table>

![Figure 10. An application program of graphic user interface.](image)

Figure 11 shows an example of the output results for testing this proposed method which the results can detect correctly the numbers and Thai characters as “น้ท 8014” of the image of license plate.

![Figure 11. An example of the output results for testing this proposed method.](image)
Table II shows examples of various images of the Thai license plate, distances between the camera and plate, as well as, the accuracy results. It can be seen from Table II that the last image does not be included in the database of training the neural network. As a result, it is a wrong result.

### Table II
EXAMPLES OF VARIOUS IMAGES OF THAI LICENSE PLATE, DISTANCES BETWEEN THE CAMERA AND PLATE, AS WELL AS, THE ACCURACY RESULTS.

<table>
<thead>
<tr>
<th>Thai license plate</th>
<th>Distances (metre)</th>
<th>Results</th>
<th>Percent of Accuracy</th>
</tr>
</thead>
<tbody>
<tr>
<td><img src="image1.png" alt="Image" /></td>
<td>0.5 m</td>
<td>✓</td>
<td>100%</td>
</tr>
<tr>
<td><img src="image2.png" alt="Image" /></td>
<td>1 m</td>
<td>✓</td>
<td>100%</td>
</tr>
<tr>
<td><img src="image3.png" alt="Image" /></td>
<td>0.5 m</td>
<td>✓</td>
<td>100%</td>
</tr>
<tr>
<td><img src="image4.png" alt="Image" /></td>
<td>0.5 m</td>
<td>✓</td>
<td>100%</td>
</tr>
<tr>
<td><img src="image5.png" alt="Image" /></td>
<td>0.5 m</td>
<td>✓</td>
<td>100%</td>
</tr>
<tr>
<td><img src="image6.png" alt="Image" /></td>
<td>0.5 m</td>
<td>✓</td>
<td>100%</td>
</tr>
<tr>
<td><img src="image7.png" alt="Image" /></td>
<td>0.5 m</td>
<td>✓</td>
<td>100%</td>
</tr>
<tr>
<td><img src="image8.png" alt="Image" /></td>
<td>1 m</td>
<td>✓</td>
<td>100%</td>
</tr>
<tr>
<td><img src="image9.png" alt="Image" /></td>
<td>0.5 m</td>
<td>✓</td>
<td>100%</td>
</tr>
<tr>
<td><img src="image10.png" alt="Image" /></td>
<td>0.5 m</td>
<td>✓</td>
<td>66.67%</td>
</tr>
</tbody>
</table>

### IV. CONCLUSION
This paper has presented the position-varied plate utilized for the Thai LPR using back propagation neural network (BPNN). In this method, a dimension image of the car is suitably decreased by image resizing (e.g. interpolation method), and then they are converted to gray images for inputs to plate localization process. The plate localization process is used to find the area position of the license plate for inputting to image segmentation process which is used to find edges of main characters in the license plate. After that, each of image characters received from character segmentation process is inserted into neural network to analyze the probable characters and numbers. In this experiment, the images of numbers and Thai characters are cross-validated by BPNN (training, validation and testing sets), and then 100 images of Thai license plate are used for testing. The results has revealed that an accuracy of analysis is at approximately 97 % for the distance of the car and camera between 0.5m to 1m, and the angle of inclined plate varied from ±13 degrees.

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### REFERENCES


