Detection and Classification of Moving Thai Vehicles Based on Traffic Engineering Knowledge

A. Leelasantitham and W. Wongseree

Abstract—This paper presents detection and classification of moving Thai vehicles based on traffic engineering knowledge. The proposed technique consists of two main parts as follows. The first part is the detection of moving vehicles using image tracking methods e.g. background and foreground (BG/FG) detection and blob tracking. Such methods can provide the values of vehicle features such as position, length (L) and width (W). The second part is the classification of Thai vehicles based on traffic engineering knowledge which is traffic management for not only controlling traffic lights on a crossroad but also calculating volume/capacity ratio and queue length. Therefore Thai vehicles normally can be separated into five groups i.e. first: bicycle, motorcycle and motor tricycle (Tuk-Tuk); second: passenger car, pickup, van and passenger pickup; third: six-wheel truck and mini bus; fourth: ten-wheel truck and big bus; fifth: eighteen-wheel truck and trailer. From above reasons, the second part uses the key features of size (W, L and W/L ratio) from each group which are applied to a decision-tree method for classifying Thai-vehicle groups. The result shows that the use of one input feature is sufficient for the differentiation between 4-group with an overall classification accuracy of 97.37%.

I. INTRODUCTION

NOWADAYS, the vision system [1] has a role especially in traffic applications for intelligent transportation system (ITS) and its system consists of tracking and classification of vehicles for a real-time system. Many papers have been published in this related research as follows. For the part of vehicle tracking, the techniques using detecting symmetry point [2], approximating optical flow [3], [4] and matching template [5] have been proposed for not only no real time but also solely vehicle tracking. Recently, there are many techniques which are presented for solving those problems such as temporal differencing [1], [6] and background extraction with differencing image [7], [8], however; the techniques cannot be used for the low illumination of road and high congestion traffic.

For the part of classification of vehicles, maximum likelihood estimation [6] has been proposed but there are some problems (e.g. the speed and size of vehicles) having the effect of error classification whilst the use of length and height has been presented in [7], however; the classification still has a problem because the length and height are not enough to classify vehicles. In addition, a method for vehicle count has been proposed in [9] using a contour description model and resolvability model for the presence of multiple-vehicle occlusions in traffic images.

In this paper, detection and classification of moving Thai vehicles is proposed using the knowledge of traffic engineering. The proposed technique consists of two main parts as follows. The first part is the detection of moving vehicles using image tracking methods e.g. background and foreground (BG/FG) detection and blob tracking [10]. Such methods can provide the values of vehicle features such as position, length (L) and width (W). The second part is the classification of Thai vehicles based on traffic engineering knowledge which is traffic management for not only controlling traffic lights on a crossroad but also calculating volume/capacity ratio and queue length. Therefore Thai vehicles normally can be separated into five groups i.e. first: bicycle, motorcycle and motor tricycle (Tuk-Tuk); second: passenger car, pickup, van and passenger pickup; third: six-wheel truck and mini bus; fourth: ten-wheel truck and big bus; fifth: eighteen-wheel truck and trailer. From above reasons, the second part uses the key features of size (L, W and L/W ratio) from each group which are applied to a decision-tree method for classifying Thai-vehicle groups. The result shows that the use of one input feature is sufficient for the differentiation between 4-group with an overall classification accuracy of 97.37%.

II. PROPOSED METHODS

A. Moving Thai Vehicle Tracking

Figure 1 shows a block diagram of moving Thai vehicle tracking using the techniques of FG/BG detection and blob tracking [10]. The block diagram can be described in the four step following. The first step is the FG/BG detection which performs foreground/background segmentation for each pixel from input of video frames. The second step is the blob entering detection which uses the result (FG/BG mask) of FG/BG detection to detect new blob object entered to a scene on each frame. The third step is the blob tracking initialized by blob entering detection which results and tracks each new entered blob. The fourth step is the trajectory generation which performs a saving function.
It collects all blobs positions and save each whole blob trajectory to hard disk when it finished (for example tracking is lost). Finally, output of blobs will provide key features e.g. Id (the number of each blob), position and size. Figure 2 shows the image results of FG/BG detection. Figures 2 (a), (b) and (c) are original, background and foreground image, respectively. Figure 3 shows vehicle tracking using blob tracking. It can be seen from Figure 3 that a big block is a region of interest when the vehicle tracking from a small block moves to this area to detect and classify the vehicles.

B. Classification of Moving Thai Vehicles Based on Traffic Engineering Knowledge

Traffic engineering knowledge is traffic management for not only controlling traffic lights on a crossroad but also calculating volume/capacity ratio and queue length. Therefore Thai vehicles normally can be separated into five groups i.e. first: bicycle, motorcycle and motor tricycle (Tuk-Tuk); second: passenger car, pickup, van and passenger pickup; third: six-wheel truck and mini bus; fourth: ten-wheel truck and big bus; fifth: eighteen-wheel truck and trailer. In this study, only four groups of Thai vehicles, as shown in Figure 4, will be used for study because there is no data of the fifth group on the Vibhavadee-Rangsit road. The types of Thai vehicles are summarized in Table 1. Three major components of the object that can be used in this case are width, length and ratios of width and length. These features are summarized in Table 2.

With the availability of data and selected choices of classifier, an investigation can be conducted as follows. Firstly, the data are pre-processed via input feature extraction and selection. The attributes are thus discretized via an information-theoretic technique [11] while redundant attributes are eliminated using a wrapper feature selection technique [12]. For testing the effectiveness of classifier, this paper tests with a decision tree learner (C4.5) [13]. This algorithm is chosen because it is relatively fast, state-of-the-art algorithm that is often used in data mining applications. Every step in the procedure described above is illustrated in Figure 5 and will be implemented using a WEKA package [14].
III. EXPERIMENTAL RESULTS

The original data contains three features as shown in Table 1. The features in classifier evaluation samples are discretized using the information-theoretic technique. The discrete interval of each feature is illustrated in Table 3. After applying the wrapper feature selection technique, it is found that attributes 2 and 3 are redundant and can be omitted from the classification task.

The candidate classifier C4.5 is benchmarked using the reduced-attribute evaluation data in stratified 10-fold cross-validation experiments (Kohavi, 1995) [15]. The number of misclassified samples, which are extracted from a confusion matrix, is given in Table 4. Table 4 shows that the use of one input feature is sufficient for the differentiation between 4-group with an overall classification accuracy of 97.37%.

A set of decision rules can be extracted from the tree illustrated in Figure 6. The decision rules can subsequently be implemented in many user-friendly computer programs including spreadsheets and databases. This is an additional advantage of using C4.5 over other classifiers.

Table 3 Discrete intervals of the features.

<table>
<thead>
<tr>
<th>Feature</th>
<th>Interval</th>
<th>Value</th>
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<tbody>
<tr>
<td>Width</td>
<td>1</td>
<td>&lt; 10</td>
</tr>
<tr>
<td></td>
<td>2</td>
<td>10 – 25</td>
</tr>
<tr>
<td></td>
<td>3</td>
<td>25 – 29.5</td>
</tr>
<tr>
<td></td>
<td>4</td>
<td>&gt; 29.5</td>
</tr>
<tr>
<td>Length</td>
<td>1</td>
<td>&lt; 17.5</td>
</tr>
<tr>
<td></td>
<td>2</td>
<td>17.5 – 36</td>
</tr>
<tr>
<td></td>
<td>3</td>
<td>36 – 44.5</td>
</tr>
<tr>
<td></td>
<td>4</td>
<td>&gt; 44.5</td>
</tr>
<tr>
<td>Ratio</td>
<td>1</td>
<td>&lt; 0.57</td>
</tr>
<tr>
<td></td>
<td>2</td>
<td>0.57 – 0.75</td>
</tr>
<tr>
<td></td>
<td>3</td>
<td>&gt; 0.75</td>
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</table>

Table 4 Confusion matrix.

<table>
<thead>
<tr>
<th>Actual class</th>
<th>Identified class</th>
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<tbody>
<tr>
<td></td>
<td>1</td>
</tr>
<tr>
<td>1</td>
<td>16</td>
</tr>
<tr>
<td>2</td>
<td>-</td>
</tr>
<tr>
<td>3</td>
<td>-</td>
</tr>
<tr>
<td>4</td>
<td>-</td>
</tr>
</tbody>
</table>

If Width = Interval1
class = 1
else if Width = Interval2
class = 2
else if Width = Interval3
class = 3
else if Width = Interval4
class = 4

Figure 6 Rule form of decision-tree learner.
IV. CONCLUSION

The detection and classification of moving Thai vehicles has been proposed using the knowledge of traffic engineering. The proposed technique consists of two main parts as follows. The first part is the detection of moving vehicles using image tracking methods e.g. background and foreground (BG/FG) detection and blob tracking [10]. Such methods can provide the values of vehicle features such as position, length (L) and width (W). The second part is the classification of Thai vehicles based on traffic engineering knowledge which is traffic management for not only controlling traffic lights on a crossroad but also calculating volume/capacity ratio and queue length. Therefore Thai vehicles normally can be separated into five groups i.e. first: bicycle, motorcycle and motor tricycle (Tuk-Tuk); second: passenger car, pickup, van and passenger pickup; third: six-wheel truck and mini bus; fourth: ten-wheel truck and big bus; fifth: eighteen-wheel truck and trailer. From above reasons, the second part uses the key features of size (L, W and L/W ratio) from each group which are applied to a decision-tree method for classifying Thai-vehicle groups. The result shows that the use of one input feature is sufficient for the differentiation between 4-group with an overall classification accuracy of 97.37%. This help emphasizes the reliability of a decision-tree as an automated vehicles classification tool.

REFERENCES