One Layer Object Separation Algorithm in Binary Image

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Abstract
We propose an algorithm to separate black object in binary image. The algorithm is designed to perform vertical separation first, then followed with horizontal separation. This process is done only once (one layer). Results showed that the algorithm potentially could be developed into n-layer separation in a recursive function. The algorithm also potentially could be developed in adaptive to determine when to use a vertical or horizontal separation first. It could be expected to reduce the recursive number.

Keywords: one layer, object separation, algorithm, binary image

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1. Introduction
There are 3 subsystems in video intelligent traffic control system, which are vehicle-detecting subsystem, vehicle-counting subsystem and timecontrolling subsystem [1]. As proposed on [1], it provided an improved algorithm for vehicle flow monitoring based on Daubechies wavelet and the experiment proved its higher accuracy than the algorithm without wavelet processing, especially under bad weather. The other research, moving vehicle detection and tracking algorithm in traffic have also presented [2, 4, 5]. It can produce the desired segmented image in binary [2] and can count the number of vehicle which passed [4]. These four articles are included into vehicle-detecting and vehicle-counting subsystem.

The one which also helpful in video intelligent traffic control system is vehicle recognition. It is very important for the traffic monitoring and regulation of highway, tunnel, highway, as well as the large parking management [3]. The research on [3] have designed geometric parameters, such as length, width, contour area, minimum bounding rectangle area, length-width ratio and space occupancy. It has also combined parameters for vehicle classification, finally sets up a vehicle classifier based on these characteristics parameters. However, it didn't explain how to separate every vehicle before doing classification. Many vehicles pass in the highway and object separation is needed before doing classification.

This paper proposes an algorithm to separate black object in binary image. The algorithm only focuses to the separation process. This can conduct the output of segmented image in binary [2] before using classification method on [3]. This also can be used to count the number of vehicle if it has a good performance.

2. Research Method
Figure 1 is the flowchart of proposed algorithm and Figure 2 is the vertical and horizontal separation algorithm. In Figure 2(a), A is 1-dimensional matrix obtained by summing array elements of binary image vertically. MaxA is the largest value of A. B is 1-dimensional matrix represents the left border of each object, while C is 1-dimensional matrix represents the right border of each object. B has the same length as C. Length1 in figure 1 is the length of B or C. In Figure 2(b), Image is a binary image obtained from separation result vertically. D is 1-dimensional matrix obtained by summing array elements of Image horizontally. MaxD is the largest value of D. E is 1-dimensional matrix represents the up border of each object, while F is 1-dimensional matrix represents low border of each object. E has the same length as F. Length2 in figure 1 is the length of E or F.
The step in Figure 2(a), column is the column number of binary image result from converting to binary, template obtained by placing maxA at the beginning and the end of A, then max is taken from maxA. While the step in Figure 2(b), column is the row number of image, template obtained by placing maxD at the beginning and the end of D, then max is taken from maxD.

Figure 1. The flowchart of proposed algorithm

Figure 2. (a) Vertical separation algorithm and (b) Horizontal separation algorithm
The algorithm to find firstindex and endindex can be found in Figure 3.

![Flowchart](image)

**Figure 3.** Flowchart to find firstindex and endindex

Figure 4 is example of a binary image and the output of processes

(a) 
```
1 1 1 1 1 1 1 1
1 0 0 1 0 1 1 1
1 0 0 1 0 0 0 1
1 1 1 1 1 1 1 1
0 0 1 1 1 0 0 0
```

(b) 
```
4 2 3 5 3 4 3 4
```

(c) 
```
5 4 2 3 5 3 4 3 4 5
```

(d) 
```
1 1 1
1 0 0
```

(e) 
```
3 1 1 3 1
```

(f) 
```
3 3 1 1 3 1 3
```

(g) 
```
1 0 0
1 0 0
```

**Figure 4.** Example of binary image taken (b) The matrix of A (c) The template of vertical separation process (d) The first image (e) The matrix of D (f) The template of horizontal separation process and (g) the first separated image
3. Results and Analysis

Table 1 is the result of separation.

<table>
<thead>
<tr>
<th>No</th>
<th>Grayscale Image</th>
<th>Binary Image</th>
<th>Separated Image</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td><img src="image1.jpg" alt="Grayscale Image" /></td>
<td><img src="image2.jpg" alt="Binary Image" /></td>
<td><img src="image3.jpg" alt="Separated Image" /></td>
</tr>
<tr>
<td>2</td>
<td><img src="image4.jpg" alt="Grayscale Image" /></td>
<td><img src="image5.jpg" alt="Binary Image" /></td>
<td><img src="image6.jpg" alt="Separated Image" /></td>
</tr>
<tr>
<td>3</td>
<td><img src="image7.jpg" alt="Grayscale Image" /></td>
<td><img src="image8.jpg" alt="Binary Image" /></td>
<td><img src="image9.jpg" alt="Separated Image" /></td>
</tr>
</tbody>
</table>

One layer separation is not necessarily produces a separated image as much as the number of objects. The second grayscale image needs two layers separation until generating 7 separated images. The third grayscale image also needs two layers separation to get the best result. This separation algorithm still has weaknesses in 2 ways:
a. The algorithm is designed with vertical separation first, then followed with horizontal separation (not adaptive). The example can be seen in the first binary image at Table 2.

b. The algorithm has not been able to separate some objects that can not be separated either vertically or horizontally. The example can be seen in the second binary image at Table 2.

<table>
<thead>
<tr>
<th>No</th>
<th>Example of Binary Image Taken</th>
<th>Separated Image</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>1 0 1 1 1 1 0 0 0 0 0 1 1</td>
<td>0 0 0 1 1 1 0 0 0 0</td>
</tr>
<tr>
<td>2</td>
<td>1 1 1 1 1 1 0 0 0 1 1 1 1</td>
<td>0 0 0 1 1 1 0 0 0 0 0 0 0</td>
</tr>
</tbody>
</table>

4. Conclusion

This separation algorithm is designed to separate black object in binary image and can be adapted to other cases. By seeing to the result of experiments mainly on the weakness, the algorithm potentially can be developed into n-layer separation in a recursive function. The algorithm also potentially can be developed in adaptive to determine when to use vertical or horizontal separation first. It is expected to reduce the recursive number.

References


