Automatic Road Sign Recognition
– EE368 Final Project

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Objective

- Automatically recognition road sign in the image
- Separate stop sign and yield sign
Algorithm

- R,G,B domain thresholding
- Remove small and large regions
- Dilation to connect fragmented part of the signs
- Remove regions whose major / minor axis ratio is too large
- Compute filling ratio the separate two signs
Algorithm

1. Input image
2. R, G, B thresholding
3. Remove small or large region
4. Remove large axis ratio region
5. Compute filling ratio
   - Small yield sign
   - Large stop sign
Algorithm

- R,G,B domain thresholding
  - Thresholding on G/R, B/R ratio (instead on G, B itself)
  - More robust to changing lighting condition
Algorithm

• Remove small and large region
  - Small region: noise, vehicle tail light cover, road pavement, etc
  - Large region: large red background (building wall)

Original image

Stop sign and part of the vehicle red tail light cover is segmented out

Only stop sign remained (after dilation) when small object is removed
Algorithm

- Remove region with large major/minor axis ratio
  - Road sign, ratio is close to 1

A red pole is also selected. It will be removed later on since its ratio is large,
Algorithm

- **Filling ratio**
  - Stop sign tend to have larger filling ratio than yield sign

\[
\text{filling ratio} = \frac{\text{area of rectangle}}{a \times b}
\]

- Stop sign, filling ratio 0.85
- Yield sign, filling ratio 0.59
Data Set

Total:

<table>
<thead>
<tr>
<th>Total Image</th>
<th>Stop Sign Image</th>
<th>Yield sign Image</th>
</tr>
</thead>
<tbody>
<tr>
<td>65</td>
<td>52</td>
<td>13</td>
</tr>
</tbody>
</table>

Divide into training and testing groups:

Training group:

<table>
<thead>
<tr>
<th>Total Image</th>
<th>Stop Sign Image</th>
<th>Yield sign Image</th>
</tr>
</thead>
<tbody>
<tr>
<td>45</td>
<td>37</td>
<td>8</td>
</tr>
</tbody>
</table>

Testing group:

<table>
<thead>
<tr>
<th>Total Image</th>
<th>Stop Sign Image</th>
<th>Yield sign Image</th>
</tr>
</thead>
<tbody>
<tr>
<td>20</td>
<td>15</td>
<td>5</td>
</tr>
</tbody>
</table>
Thresholds

- Training data is used to choose the thresholds of the algorithm
  - For each image, manually select an area on the traffic sign, record the properties.
  - Select thresholds so that traffic signs in most of the training image can be correctly segmented out.
Thresholds

- **Selected thresholds:**
  - MinR: 65, maxR: 255, minG/B: 0, maxG/B: 0.7, minB/R: 0, maxB/R: 0.7
  - Minimum size: 40 pixels
  - Maximum size: 400000 pixels
  - Filling ratio threshold: 0.7
Results

• The algorithm is applied on all images and testing images:

• All images:

<table>
<thead>
<tr>
<th></th>
<th>total</th>
<th>Stop sign</th>
<th>Yield sign</th>
</tr>
</thead>
<tbody>
<tr>
<td>detected</td>
<td>65</td>
<td>52</td>
<td>13</td>
</tr>
<tr>
<td>missed</td>
<td>11 (16.9%)</td>
<td>9 (17.3%)</td>
<td>2 (15.4%)</td>
</tr>
<tr>
<td>False detection*</td>
<td>10 (15.4%)</td>
<td>8 (15.3%)</td>
<td>2 (15.3%)</td>
</tr>
</tbody>
</table>

* False detection means the traffic sign in the image is identified, however, the algorithm also picks up other region in the image as traffic sign
Results

- Testing images:

<table>
<thead>
<tr>
<th></th>
<th>total</th>
<th>Stop sign</th>
<th>Yield sign</th>
</tr>
</thead>
<tbody>
<tr>
<td>detected</td>
<td>20</td>
<td>15</td>
<td>5</td>
</tr>
<tr>
<td>missed</td>
<td>4 (20.0%)</td>
<td>2 (13.3%)</td>
<td>2 (40.0%)</td>
</tr>
<tr>
<td>False detection*</td>
<td>2 (10.0%)</td>
<td>2 (13.3%)</td>
<td>0 (0%)</td>
</tr>
</tbody>
</table>
Examples

- Stop sign detection

original

after rgb thresholding

after removing small regions

after dilation

final filling ratio 0.82
Examples

- Yield sign detection:

  - Original
  - After RGB thresholding
  - After removing small regions
  - Final, filling ratio 0.60
Conclusion

- This algorithm achieved about 80% correct detection rate in testing image and in whole image group as well.
Limitation

- Fail to recognize sign when it is connect with other red object
- Fail to work when it is too dark

stop sign not recognized since it is connected with a red pole
stop sign not segmented out since it is too dark