Localization of Brazilian Vehicles Plates Using Frequency Analysis

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Abstract. This work aims the implementation of the Brazilian vehicle plate localization using image processing techniques. In this paper, we present how to find the horizontal position of the plate based on its frequency characteristics in the whole vehicle image. Preliminary results show efficiencies above 96% for images in good illumination conditions.

1. Introduction
Since 1999, we have been developing a Brazilian vehicle plate recognition system using image processing techniques [1]. This work is one of the stages of this system: locating the vehicle plate in the entire image. It was divided in three parts: (i) plate localization in the y axis; (ii) plate localization in the x axis; and (iii) plate extraction. In this paper, we discuss the first part of the localization stage.

The proposed method is based on frequency analysis of the plate, determining two frequencies characteristics \(f_1, f_2\) in images with 2 mm/pixels of resolution [1] (i.e. height \(\approx 25\) pixels/character). Thereafter, we have created a database with approximately 200 vehicles images each one with the plate coordinates, manually extracted. At last, we built 15 algorithms to estimate the horizontal position of the plate and calculate their efficiencies based on the storage coordinates.

2. Development
The developed algorithms to find the vehicle plate applies a bandpass filter \((f_1, f_2)\) in each line \(x_i\) of the image that was Fourier transformed, calculated by:

\[
X_n = TF[(x_n)] \prod f_1, f_2 \forall y[1, Ny] 
\]  

After that, we search for the highest energy level using the sliding window technique [2] (width \(W\)). Finally, the highest value is selected representing the horizontal position \(y_{des}\) of the plate, defined by:

\[
y_{des} = \max[W(X_n)] \forall y[1, Ny] 
\]  

3. Results
We studied different frequencies \((f_1, f_2)\) and window widths \(W\). Table 1 presents the efficiencies of the studied algorithms, defined by three normalized frequency characteristics and five different window widths.

<table>
<thead>
<tr>
<th>((f_1, f_2))</th>
<th>15</th>
<th>20</th>
<th>25</th>
<th>30</th>
<th>35</th>
</tr>
</thead>
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<tr>
<td>0.07-0.08</td>
<td>82.5%</td>
<td>86.0%</td>
<td>92.5%</td>
<td>88.5%</td>
<td>82.5%</td>
</tr>
<tr>
<td>0.07-0.09</td>
<td>84.5%</td>
<td>94.0%</td>
<td>94.5%</td>
<td>90.0%</td>
<td>88.5%</td>
</tr>
<tr>
<td>0.07-0.10</td>
<td>86.0%</td>
<td>96.5%</td>
<td>96.5%</td>
<td>96.5%</td>
<td>94.5%</td>
</tr>
</tbody>
</table>

Table 1: Vehicle plate horizontal position localization algorithms efficiency.

In Table 1, we observe that the highest efficiency achieve 96.5% for three algorithms \(f_1=0.07, f_2=0.1\) and \(W=20, 25\) and 30. Finally, the best algorithms use approximately the same window width as the characters height.

4. Conclusions
The plate localization system in the vehicle image is under development. Combining line frequency analysis with sliding window technique we show a simple and useful method to find the horizontal position of the plate.

5. References