Enhanced SURF-based Image Matching using Pre- and Post-Processing

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Introduction

Motivation

The object recognition application is widely used in the automatic production lines. The traditional SIFT and SURF algorithm can’t perform well when the images have low contrast or the noise has similar local features with the interest points.

Key Idea

E-SURF using pre- and post-processing is developed to promote the robustness in these challenging cases (especially the poor illumination conditions and local-feature-similar noises): Median filtering and Histogram linear transformation is adopted as the preprocessing to remove the isolated noises and amplify the illumination contrast. LBP based filtering is used to filter the possible false matching points using local texture features.

Main Method

The Proposed E-SURF Algorithm

Original images

Median Filtering

Histogram Linear Transformation

SURF-based Matching

LBP-based Filtering

Result images

Method

Histogram linear transformation and median filtering

Given an image with low contrast, the gray values of those images histogram are within a very small range, which causes the failure of interest point detection. We use Histogram linear transformation to enhance the contrast of images.

\[ r' \in [r_a + r_b] \]

The isolated noises in the original images, such as salt-and-pepper noises, will make up as corner points and result in false matching easily. Median filter algorithm can be a proper method of removing those noises before the Histogram linear transformation.

\[ g(m,n) = \text{Median}_{i,j} [f(i,j)] \]

LBP-based filtering

In a realistic scenario, there will be many similar corner points and noise in an image. LBP is taken into consideration. LBP-based filtering can be used as one post-processing to remove the error matching points which have similar Haar wavelet feature but different LBP feature.

\[ value = \sum_{i=0}^{\text{value}} f(g_i - g_v) \times 2^v \]

Results

The E-SURF algorithm is evaluated on a standard evaluation set and an industrial object recognition application. As can be seen, E-SURF improves the robustness and accuracy of the interest point detection and matching in most conditions.

Objective Results

Correct Matching Rate of Test Images

<table>
<thead>
<tr>
<th>Method</th>
<th>SIFT</th>
<th>SURF</th>
<th>SURF with Pre-processing</th>
<th>Proposed E-SURF</th>
</tr>
</thead>
<tbody>
<tr>
<td>First test group</td>
<td>0.00%</td>
<td>0.00%</td>
<td>88.9%</td>
<td>100%</td>
</tr>
<tr>
<td>Second test group</td>
<td>86.67%</td>
<td>86.29%</td>
<td>96.20%</td>
<td>100%</td>
</tr>
<tr>
<td>Third test group</td>
<td>40.00%</td>
<td>0.00%</td>
<td>100%</td>
<td>100%</td>
</tr>
<tr>
<td>Fourth test group</td>
<td>13.84%</td>
<td>16.00%</td>
<td>28.95%</td>
<td>75.00%</td>
</tr>
</tbody>
</table>

Subjective Results

Images from left to right: the first group is matching result using original SIFT algorithm; the second group is matching result using SURF algorithm; the third group is result using SURF with Pre-processing; the fourth group is result using the proposed E-SURF.

Conclusion

With median filtering and histogram linear transformation as preprocessing, and LBP feature based filtering as post-processing, the proposed E-SURF algorithm is suitable to detect interest points with the image for very low contrast or very low brightness, and it can improve the correct matching rate at the same time.

Reference


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