ROTATION AND SCALE INVARIANT IMAGE MATCHING USING ITERATIVE FEATURE POINT DETECTION

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Abstract: - The variations of illumination and view in local feature based image matching have many challenges. To solve these challenges we propose a method invariant feature detectors and distinctive descriptors. When a large variation in view or illumination occurs the matching performance will be still inaccurate and unstable, so we propose the relationship of the relative view and illumination of the images estimates iteratively, transform the view of the one image to other , and normalize their illumination for accurate matching of images. The proposed method improves the stability, accuracy, and reliability of the matching outputs but not aim to increase the invariance of the detector. The matching performances is not affected by view and illumination changes in a valid range and improved significantly. When the initial view and illumination method fails, our proposed method would fail, which gives us a new sight to evaluate the traditional detectors. In this paper proposes a novel indicator for evaluation of detector, namely valid illumination and valid angle, which reflects the maximum allowable change in view and illumination respectively.

Keywords:-Image matching, valid illumination (VI), valid angle (VA), Feature detector evaluation.

I.INTRODUCTION

Feature-based image matching is a key task in many computer vision applications, such as object recognition, images stitching, structure from motion and 3D stereo reconstruction. Each point to be matched must be identified by describing it and its surroundings so that it can be matched to descriptions of points in another image. It is important that a point’s description be as unique as possible while also allowing for various image transformations due to differences in lighting, object movement, and changes in camera pose.

The SIFT algorithm, proposed in [1], is currently the most widely used in computer vision applications due to the fact that SIFT features are highly distinctive, and invariant to scale, rotation and illumination changes. However, the main drawback of SIFT is that the computational complexity of the algorithm increases rapidly with the number of keypoints, especially at the matching step due to the high dimensionality of the SIFT feature descriptor. In order to overcome this drawback, various modifications of SIFT algorithm have been proposed. One such modification is proposed in this paper.

This paper is organized as follows: section II explains about the conventional SIFT algorithm extending with the proposed algorithm in the section III and ending up with the experimental results in section IV and V.

II.RELATED WORK

a) SIFT (Scale invariant feature Transform)

The following steps are followed in the algorithm

1) Construct Scale space: Gaussian kernel used to create scale space i.e;

\[ L(x, y, \sigma) = G(x, y, \sigma) * I(x, y) \]  \hspace{1cm}  (1)

Where \( G(x, y, \sigma) = \frac{1}{2\pi \sigma^2} e^{-\frac{(x^2+y^2)}{2\sigma^2}} \)

2) Take the difference of Gaussian

Approximations of Laplacian of Gaussians

\[ D(x, y, \sigma) = (G(x, y, k\sigma) - G(x, y, \sigma)) * I(x, y) \]

\[ = L(x, y, k\sigma) - L(x, y, \sigma) \]  \hspace{1cm}  (2)

3) Locate the extrema of the DOG

Scan each of DOG images, by considering all the neighboring points and identify the minimum and maximum values
4) Sub pixel location and potential of feature points

This section mainly concentrates on the curve fitting based on Taylor series expansion and differentiation to get location of the points \((x,y,\sigma)\).

5) Filter Edge and low contrast responses:

In this section low contrast points are filtered

\[
D(\hat{x}) = D + \frac{1}{2} \frac{\partial D^T}{\partial x} \hat{x}
\]

(3)

6) Assign key point orientations

In this section gradient is calculated for the blurred image obtained from the above steps

\[
m(x,y) = \sqrt{(L(x+1,y)-L(x-1,y))^2 + (L(x,y+1)-L(x,y-1))^2}
\]

(4)

\[
\theta(x,y) = \tan^{-1}\left(\frac{(L(x,y+1)-L(x,y-1))/(L(x+1,y)-L(x-1,y))}{1}ight)
\]

(5)

Create histogram with 36 bins for orientation and eight each point with Gaussian window of 1.5\(\sigma\) and then create key points for all peaks with value >=.8

This method suffers from few limitations like the computational complexity of the algorithm increases rapidly with the number of key points, especially at the matching step due to the high dimensionality of the SIFT feature descriptor. To overcome these drawbacks one of the alternate approaches is proposed in this paper.

III.PROPOSED METHODOLOGY

Denote the reference image and test image to be matched as \(I_r\) and \(I_t\). Suppose that the true pose transformation matrix from \(I_r\) to \(I_t\) is \(H\) and the illumination change function is \(L\). The relationship between \(I_r\) and \(I_t\) is

\[
I_r(X) = T(I_t) = L(I_t(HX))
\]

(7)

Where \(H\) denotes the view point transformation and \(L\) denotes the illumination transformation. If \(T\) is not a very rough estimation between \(I_r\) and \(I_t\), the estimated image \(I_t\) would be more similar to \(I_r\) and \(I_t\). Thus, the matching between \(I_r\) and \(I_t\) will be easier, as in this way, we propose the following iterative image matching process

\[
l_1x = T_1(l_0) = L_1(l_0(H_1x^T)) \quad (l_0 = l_t)
\]

(8)

Proposed methodology

Initial: \(T_0 = \{H_0, T_0\} = \{E, \bar{l}\} \), \(T = T_0, \sigma_H, \sigma_L\);

Iterate

\[
i = i + 1;
\]

Estimate \(T_i\) : \(H_i l_i\);

\[
T = T_i \propto T;
\]

\[
H = H_i \ast H
\]

Transform \(l_{i-1}\) to \(l_i\) by (3);

Until \(H_i E < \sigma_H, \|l_t - \bar{l}\| < \sigma_L\) or \(i > n\). (\(E\) is the unit matrix \(l_{i-1}\), is a histogram transformation vector, \(\sigma_H\) and \(\sigma_L\) are convergence thresholds.)

Return , \(T, H\)

The final estimation of the \(\hat{T}\) is

\[
\hat{T} = \cdots \circ T_m \circ T_{m-1}\circ \cdots \circ T_2 \circ T_1 \approx T_n \circ T_{n-1} \circ \cdots \circ T_2 \circ T_1
\]

(9)

Where “\(\circ\)” denotes function composition. Our experiments show the convergence of the iteration with SIFT and the performance with respect to the number of iterations.
IV. EXPERIMENTAL ANALYSIS

The experiment for the proposed algorithm is conducted on different affine transformed and illumination changed images and the performance evaluation is conducted for average accuracy of matching and the percentage of matching points.

Figure 1: Illumination changes and its corresponding histograms

Figure 2: Sample Images used in the experimental analysis

Figure 3: (a) (b) shows the feature points detected for affine transformed images using SIFT and (c) (d) shows the proposed iterative approach

Figure 4: performance analysis of the SIFT and ISISIFT for different view angles

Figure 5: Performance of the proposed and SIFT algorithms for changes in the illumination

Table 1: Comparison of statistical parameters of the proposed method with existing methods

<table>
<thead>
<tr>
<th>Method</th>
<th>Total</th>
<th>Matches</th>
<th>NCM</th>
<th>RS</th>
<th>MP</th>
</tr>
</thead>
<tbody>
<tr>
<td>SIFT</td>
<td>882</td>
<td>157</td>
<td>40</td>
<td>4.53</td>
<td>25.4</td>
</tr>
<tr>
<td>ASIFT</td>
<td>872</td>
<td>131</td>
<td>28</td>
<td>3.21</td>
<td>21.37</td>
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<tr>
<td>SURF</td>
<td>1999</td>
<td>733</td>
<td>184</td>
<td>9.20</td>
<td>25.1</td>
</tr>
<tr>
<td>Proposed</td>
<td>882</td>
<td>159</td>
<td>41</td>
<td>4.58</td>
<td>25.5</td>
</tr>
</tbody>
</table>

NCM: no. Of Corrected matches
RS: Repeatability Score
MP: Matching Precision
V. CONCLUSION

An improved version of SIFT is explained in this paper which could overcome the limitation of the conventional SIFT algorithm. Here from the experimental results we could prove that the proposed method gives and increment of 2% in the matching ratio and precision values. Experiments were conducted on several images considering the different view angles and changes in the illuminations and tested with statistical parameters. In the entire above scenario the proposed method outstands than the existing algorithms.

REFERENCES