MOBIL: A Moments based Local Binary Descriptor

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Abstract

In this paper, we propose an efficient, and fast binary descriptor, called MOBIL (MOments based BInary differences for Local description), which compares not just the intensity, but also sub-regions geometric proprieties by employing moments. This approach offers high distinctiveness against affine transformations and appearance changes. The experimental evaluation shows that MOBIL achieves a quite good performance in term of low computation complexity and high recognition rate compared to state-of-the-art real-time local descriptors.

Index Terms: I.4.8 [Image Processing and Computer Vision]: Scene Analysis; H.5.1 [Information Interfaces and presentation]: Multimedia Information Systems – Artificial, augmented, and virtual realities.

Keywords: Computer vision, local binary descriptors, moments, Augmented reality.

1 Introduction

Local descriptor methods are fundamental techniques in computer vision. They enable local regions to be compared, despite changes in viewpoint and appearance, and are used in many applications such as augmented reality, 3D scene reconstruction, and robot navigation. However, these binary descriptors employ simplified information for binary tests, and thus have low discriminative ability.
To overcome this problem, we propose an alternate binary descriptor, with supplementary information for the binary test, such as geometric properties to increase the distinctiveness level.

2 Related Works

Many robust algorithms have been proposed for the reliable matching in the literature. SIFT [1] has been the most popular approach due to high robustness to many of the variations and distortions. For the computational efficiency, Bay et al. proposed SURF [2], which approximates to SIFT and outperforms other methods. Although these conventional algorithms show the competitive performance, but they have high computational complexity.Recently, fast approaches have been proposed, by comparing local intensity segments, such as BRIEF feature descriptor [3], ORB [4], BRISK [5], FREAK [6].
However, using the intensity test gives an insufficient description of the patch. LDB [7] applied in addition, the first-order gradient to improve the description quality. Despite that, its sensitivity to viewpoints changes, and noise, is significant.
In this work, we introduce a geometric information test, by calculating moments for each sub-region of the patch, to enhance the robustness and distinctiveness during the description step.

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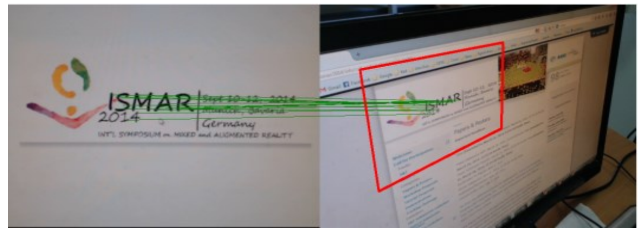

Figure 1: MOBIL descriptor matching test.

3 MOBIL, an Alternate Fast Binary Descriptor

The idea behind the MOBIL descriptor is inspired from LDB, in which an image patch was divided into grids. Except, that for LDB descriptor, a first-order gradient is calculated for sub-regions and compared to get a binary differences. In fact, gradient is less-sensitive to brightness changes, but, it has a low resistivity against affine transformations and viewpoint changes. So, in our case, we perform a geometric properties comparison between the patch sub-regions, by calculating fundamental moments for each one.
As given by Hu [8], the two-dimensional moment for an (N x M) image, I(x , y), is defined by(1), where p,q = 0,1,2.
In our case, we calculate the zero[th] (m_{00}), the first (m_{10}, m_{01}) and the second (m_{20}, m_{02}) order moments, where:

$$m_{pq} = \sum_{y=0}^{M-1}\sum_{x=0}^{N-1} x^p y^q I(x,y) \qquad (1)$$

- Zero[th] order moment (m_{00}) represents the total *mass (or sum of pixels values)* of the given image region.
- Firsts order moment (m_{10}, m_{01}) are used to locate the *centroid (center of gravity)* of a region.
- Second order moments (m_{20}, m_{02}) determine the *principal axes* of the pixels distribution given in the image.

For the keypoints detection, we apply the same technique as ORB to get more stable keypoints (Fast [9] filtered by Harris [10]) and we employ a scale pyramid of the image, to produce feature points at each level in the pyramid.

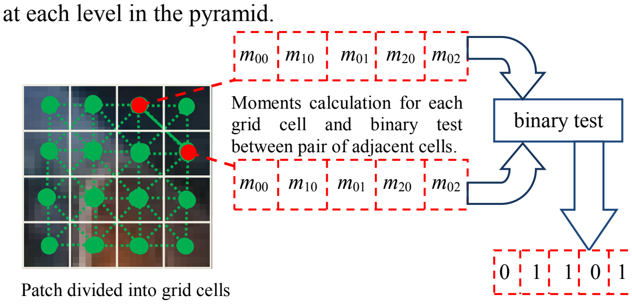

Figure 2: Illustration of MOBIL description algorithm.

Once keypoints are detected, we take a patch around the keypoint. In order to make our descriptor invariant to in-plane rotation, we estimate a dominant orientation for a patch and align the patch to this orientation before computing its descriptor, we apply the intensity moments based method [4] for its good performance and efficiency.

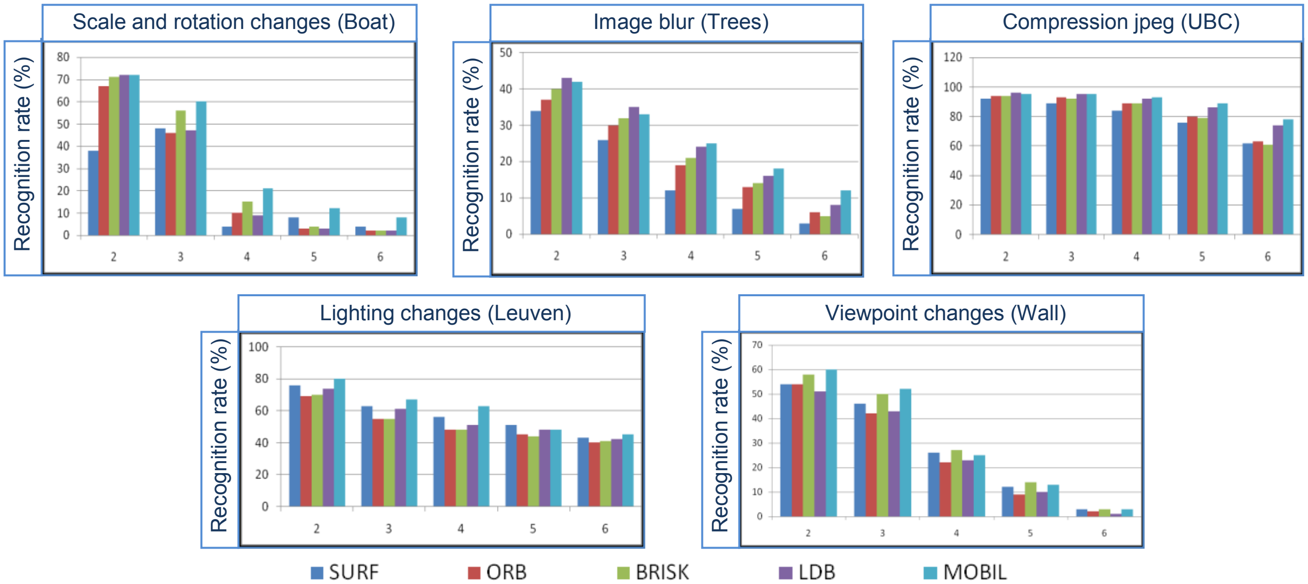

Figure 3: Evaluation result shows recognition rate for MOBIL, LDB, ORB, BRISK, and SURF

Then we divide the rotated patch into (4x4) equal-sized grids. After a set of tests for the sampling pairs, we found that taking pairs of grid cells with small distance gives better results in the case of viewpoint changes.

So, we calculate for each grid cell the five (5) moments defined above, and we perform a binary test on each pair of adjacent grid cells. We get as an output, a vector of five binary values for each test, as demonstrated in Figure (2).

4 Test and Evaluation

We have implemented our proposed descriptor under Visual Studio 2013 environment, with OpenCV 2.4.4, running on an Intel(R) Core (TM) i3 of 3.20GHz. We have tested it on the Mikolajczyk database [11]. Comparing with the state-of-the-art techniques, first results achieved (see Figures 1 and 3) demonstrate that this proposed approach, presents a high recognition rate (*Recognition Rate is* the number of correct matches divided by the total number of matches) against scale and rotation, and viewpoint changes.

Also, we calculated the description time, and we compared it, with other feature descriptors. As shown in Table 1, MOBIL gives low construction time, than ORB and LDB, and much better than SURF.

Table 1. Time per description for the tested state-of the-art descriptors and MOBIL descriptor

Descriptors	Time per description (ms)
SURF	1.488
BRISK	0.062
ORB	0.146
LDB	0.139
MOBIL	0.127

5 Conclusion

In this paper we have presented a first version of our proposed binary descriptor (MOBIL), in which we have introduced geometric information as binary tests, to enhance its robustness and distinctiveness.

The first and positive results achieved, show its performance and efficiency relative to other popular features descriptors, and demonstrate that this description technique gives more robustness and distinctiveness especially against affine transformation, and viewpoint changes. Although, this new approach gives us new ideas to improve the performance and efficiency of the proposed MOBIL descriptor in the near future.

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