Shape and Moment Invariants Local Descriptor for Structured Images

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Abstract

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Keywords: image mathching, shape descriptors, moment invariants,

1 Introduction

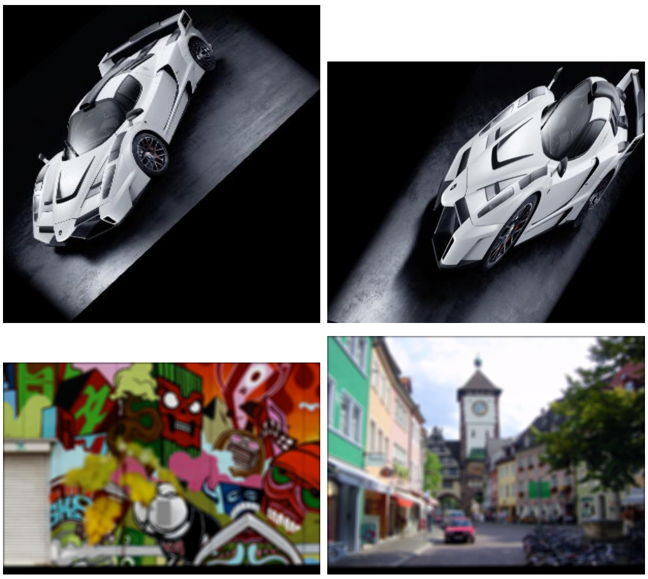

Figure 1: “Is it the same object or scene?” Matching two images under different transformation using local interest regions detected by MSER.
Top image pair (scale and viewpoint): SURF descriptor yields false negative (similarity score 0.096), while the proposed SMI descriptor - true positive (0.89).
Bottom image pair (blur): SURF gives false positive (0.27), while SMI - true negative (-0.11).

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2 Related Work

2.1 Salient region detectors

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2.2 Region descriptors

State of the art in region descriptor

3 Image matching with Shape and Moment Invariant descriptor

We propose a set of several Shape and Moment Invariants (SMI) to encode each salient region into a feature vector (descriptor) used for the region matching. The SMI descriptor contains two parts: *simple shape invariants* and *moment invariants*.

$$SMI_i = \{S_i, M_i\} \tag{1}$$

3.1 Simple shape invariants

A binary shape of a region R_i can be described by a set of simple shape properties defined over the original shape or over the equivalent ellipse E_i with seond order moments the same as the region. These properties are: the region's area a_i, the area of the region's covex hull a_i^c, the length of the major and minor axes of E_i, μ_i and ν_i and the distance between the foci of the ellipse ϕ_i.From these basic properties, a set of affine invariants are defined in Table 1.

Invariant	Definition	Description
Relative Area	$\tilde{a}_i = a_i / A$	region's area normalized by the image area A
Ratio Axes Lengths	$r_i = \nu_i / \mu_i$	ratio between E_i minor and major axes lengths
Eccentricity	$e_i = \phi_i / \mu_i$	$e_i \in [0, 1]$ (0 is a circle, 1 is a line segment.)
Solidity	$s_i = a_i / a_i^c$	proportion of the convex hull pixels, that are also in the region.

Table 1: Simple shape invariants.

The simple shape invariants part of SMI_i is

$$S_i = \{\tilde{a}_i, r_i, e_i, s_i\} \tag{2}$$

3.2 Moment invariants

Moment invariants are a group of efficient invariant object descriptors. Flusser et al. introduced a general framework for the derivation of moment invariants of any order. [Flusser, 2006]

3.3 Matching

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4 Performance Evaluation

4.1 VGG dataset

The performance results on the VGG dataset are summarized in Table 2.

Det. + descr.	TP	TN	FP	FN	Acc.	Prec.	Recall
MSER + SURF	128	428	4	16	0.965	0.969	0.889
MSER + **SMI**	122	430	2	22	0.958	0.98	0.847
BIN + SURF	122	426	6	22	0.951	0.953	0.847
BIN (All) + **SMI**	84	432	0	60	0.89	1	0.58
BIN (Largest) + **SMI**	112	424	8	32	0.93	0.93	0.77

Table 2: Performance of salient region detectors and descriptors on the VGG dataset.

4.2 OxFrei dataset

The performance results on the VGG dataset are summarized in Table 3.

Det. + descr.	TP	TN	FP	FN	Acc.	Prec.	Recall
MSER + SURF	3309	28848	2904	660	0.90	0.53	0.83
MSER + **SMI**	2957	31162	590	1012	0.95	0.83	0.74
BIN + SURF	2513	28198	3554	1456	0.85	0.41	0.63
BIN (All) + **SMI**	1275	31298	454	2694	0.91	0.73	0.32
BIN (Largest) + **SMI**	2079	28474	3278	1890	0.85	0.38	0.52

Table 3: Performance of salient region detectors and descriptors on the OxFrei dataset.

5 Conclusion

A VGG dataset matching results

B OxFrei dataset matching results

References

[Flusser, 2006] Flusser, J. (2006). Moment invariants in image analysis. *Trans. on Engineering, Computing and Technology*, 11(2):196–201.