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Asymmetric discriminative correlation filters for visual tracking

Key words: Visual tracking; Discriminative correlation filter (DCF); Asymmetric DCF (ADCF)

Corresponding author: Li LU
E-mail: luli@scu.edu.cn

ORCID: https://orcid.org/0000-0001-7904-8821

Motivation

- Generalized translation equivariance is an important concept for visual tracking, which, however, has not been well recognized in the field.
- Discriminative correlation filters (DCFs) based trackers can learn very efficiently but lack the desired generalized translation equivariance property. Besides, the scalability of these trackers is poor.

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Main idea

- After illustrating the importance of the concept of generalized translation equivariance in visual tracking, we analyze why the symmetry of correlation (or convolution) operator used in DCF lacks this desired property and results in poor model scalability.
- We propose an asymmetry convolution operator and show that it satisfies a week generalized translation equivariance, based upon which we construct trackers with better model scalability.

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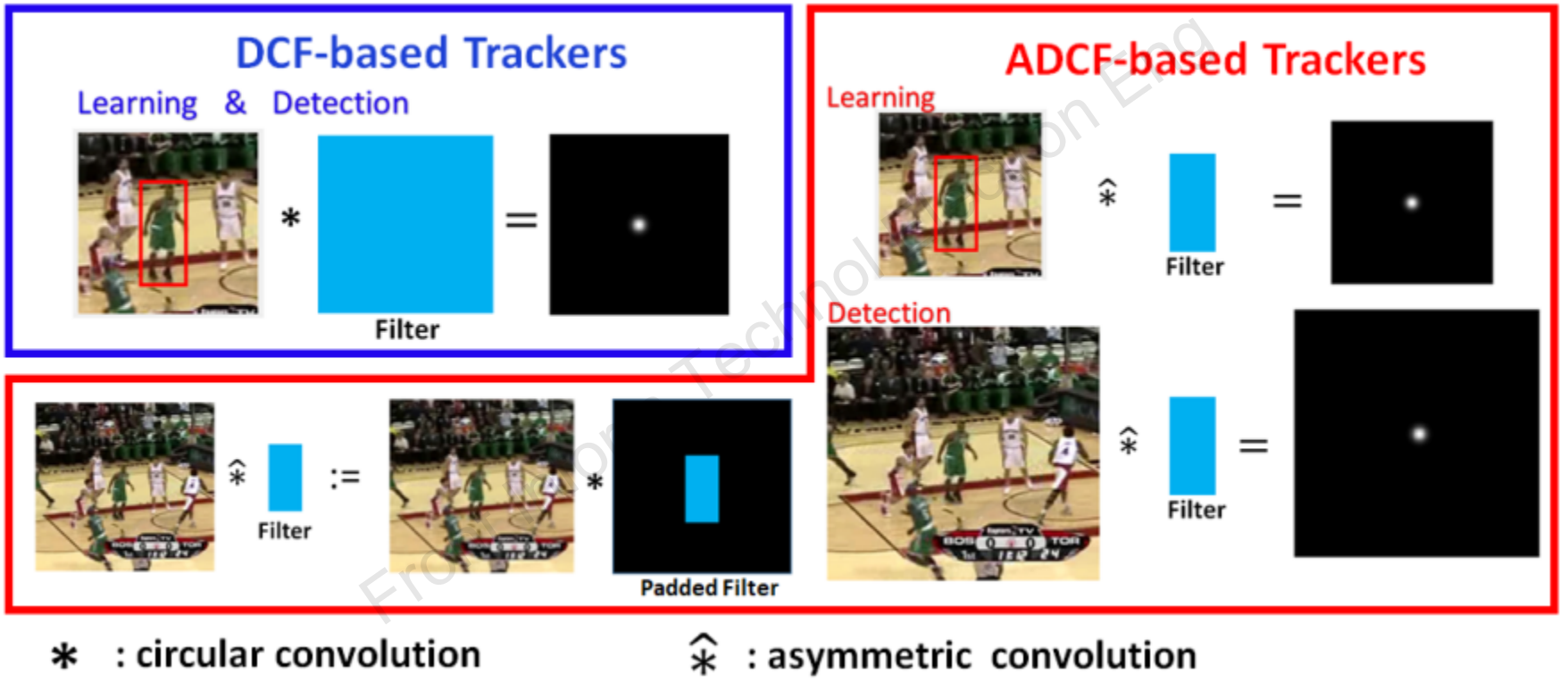
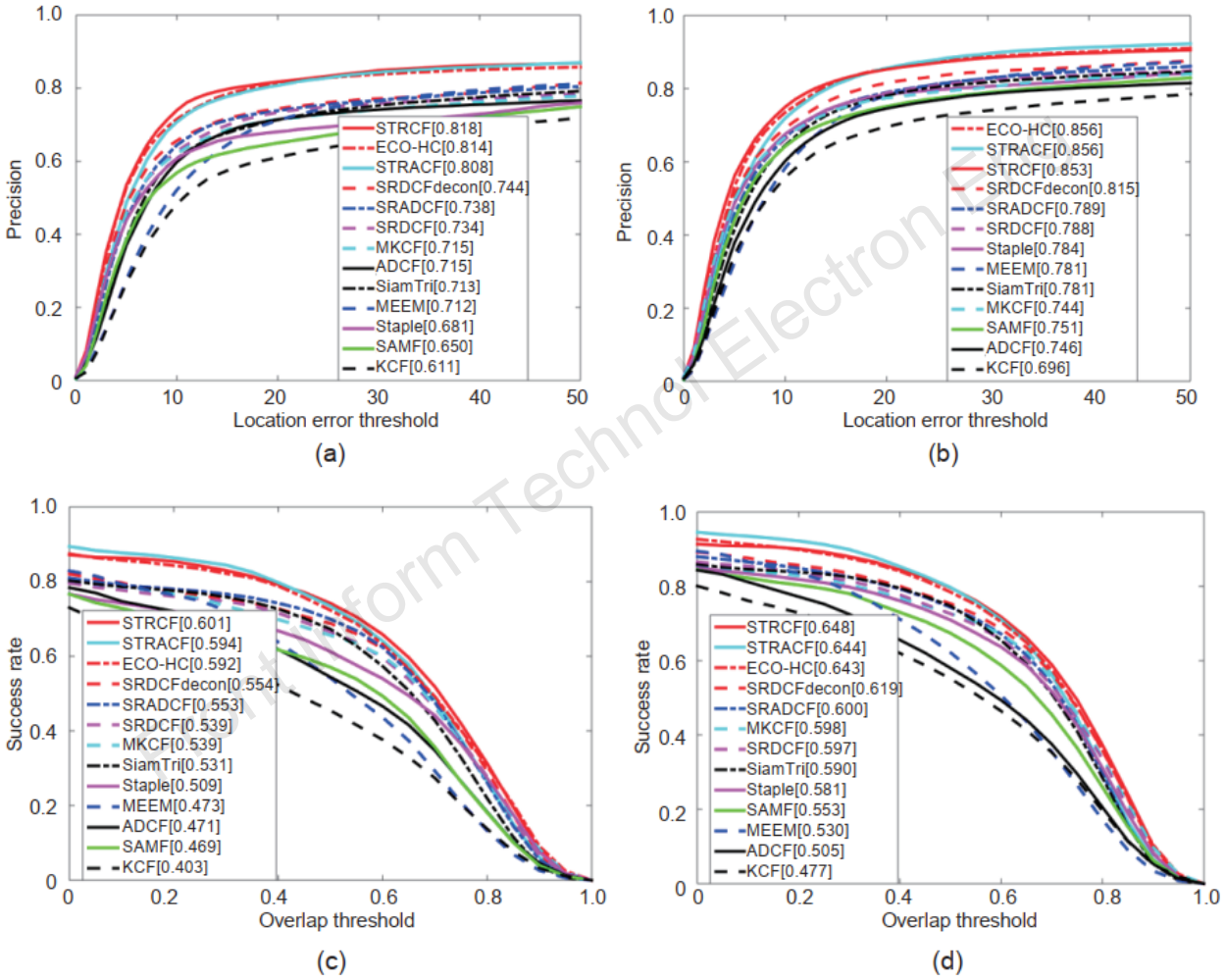
Main idea



Comparison of tracking frameworks between DCF and the proposed ADCF

Major results



(a) and (b) show the precision plots on OTB-2013 and OTB-2015, respectively;
(c) and (d) show the success plots on OTB-2013 and OTB-2015, respectively.

Major results

Mean OP and FPS results of state-of-the-art trackers on OTB-2013 and OTB-2015

Tracker	Mean OP (%) (OTB-2013)	Mean OP (%) (OTB-2015)	FPS (OTB-2015)
KCF	45.5	55.2	**211.4**
ADCF	54.4	58.0	37.4
MEEM	54.2	62.2	27.6
SAMF	57.1	67.4	28.5
Staple	61.2	70.9	**94.3**
MKCF	65.6	72.2	**64.7**
SiamTri	67.2	74.7	30.6
SRDCF	66.5	72.7	7.1
SRADCF	69.9	74.0	27.5
SRDCFdecon	68.8	75.3	2.5
ECO-HC	**72.3**	**78.4**	51.7
STRCF	**74.2**	**79.6**	29.9
STRACF	**73.4**	**79.7**	25.4

OP: overlap precision; FPS: number of frames per second. The best three results are in bold

Comparison with state-of-the-art trackers on the VOT-2016 dataset

Tracker	EAO	Accuracy	Robustness
DSST	0.173	0.50	2.58
SAMF	0.166	0.48	2.48
ACT	0.173	0.43	2.37
SRDCF	0.181	**0.52**	2.30
SRADCF	0.189	0.51	2.13
SRDCFdecon	0.193	0.51	2.23
DAT	0.217	0.46	1.72
BACF	0.239	**0.54**	1.67
SiamTri	0.240	0.48	1.85
ECO-HC	**0.279**	**0.52**	**1.28**
STRCF	**0.259**	**0.53**	**1.42**
STRACF	**0.251**	**0.52**	**1.38**

EAO: expected average overlap. The best three results are in bold

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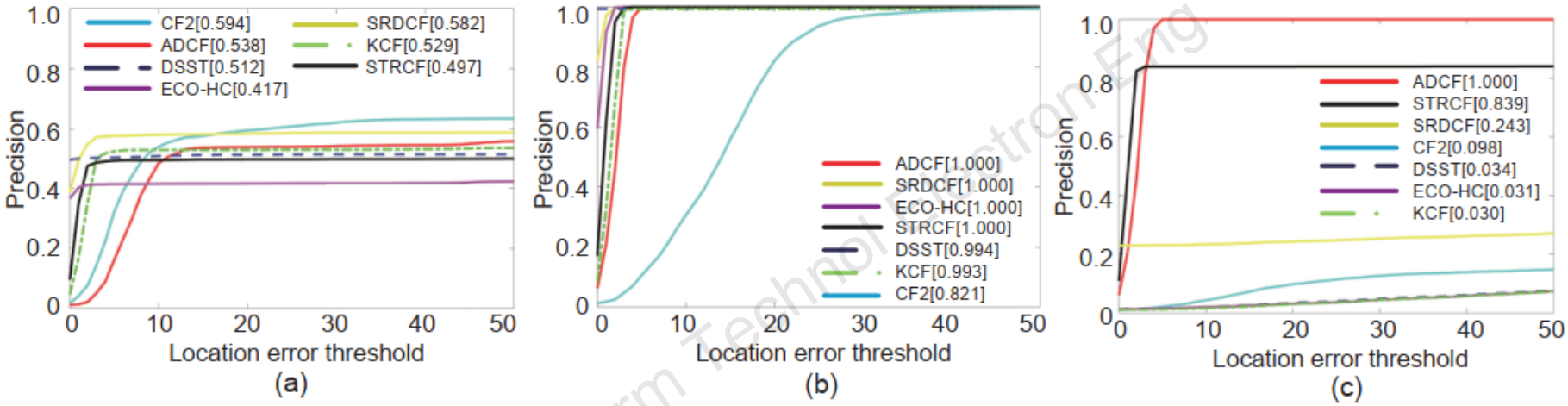
Major results



(a) and (b) show the precision plots of all competing trackers on Syn-a with A_f/A_t=5 and 10, respectively; (c) shows the precision plot on Syn-b with A_f/A_t=10

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Major results

FPS of trackers with ratio A_f/A_t=5, 10

Tracker	FPS@5	FPS@10	FPS@5/FPS@10
KCF	69.71	8.89	7.84
DSST	8.81	1.95	4.52
CF2	1.20	0.65	**1.85**
SRDCF	0.62	0.13	4.77
ECO-HC	30.65	7.73	**3.97**
STRCF	9.24	1.79	5.16
ADCF	49.20	11.30	**4.35**

FPS@5/FPS@10 represents the ratio of FPS@5 to FPS@10. The best three results are in bold

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Qualitative evaluation on six video sequences from OTB-2015

Conclusions

- We proposed an asymmetric discriminative correlation filter (ADCF) to deal with the problems from which DCF may suffer.
- We showed that ADCF has weak generalized translation equivariance and better model scalability.
- We showed that the normal matrix of ADCF is well structured and that fast algorithms can be designed for parameter optimization.
- We explored spatial and temporal regularizations to boost the performance of ADCF and demonstrate the superiority of our proposed method on four public benchmarks and a synthetic dataset.

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