HYBRID CENTER-SYMMETRIC LOCAL PATTERN FOR DYNAMIC BACKGROUND SUBTRACTION

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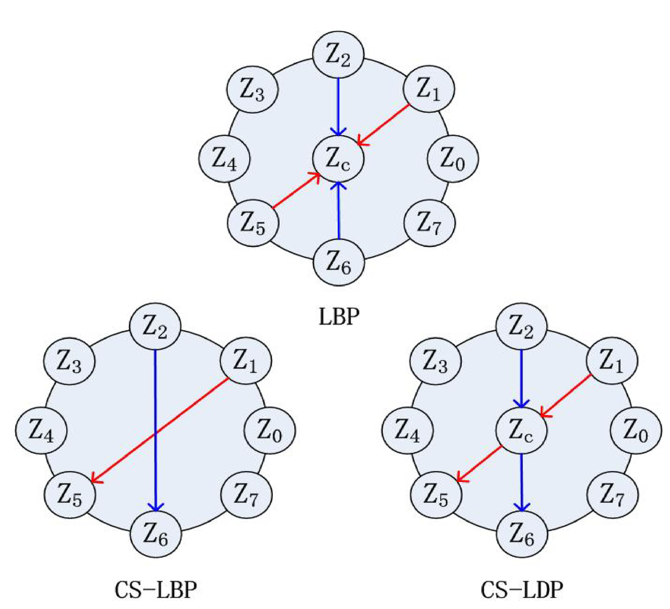
Introduction

We focus on moving objects detection under dynamic scenes. First, a second-order center-symmetric local derivative pattern (CS-LDP) is proposed, which extracts more detail information compared with the first-order center-symmetric local binary pattern (CS-LBP). Then by concatenating the CS-LBP and CS-LDP histograms, a new hybrid histogram feature is presented. The length of this histogram is much shorter than the local binary pattern (LBP) histogram. Based on this hybrid feature, a novel background modeling method is proposed where the pixel process is modeled with a group of adaptive hybrid histograms. Our method is robust to dynamic background and has low complexity. Experimental results justify our method.

Methods

● New hybrid feature



$$LBP_{R,N} = \sum_{i=0}^{N-1} s(z_i - z_c)2^i$$

$$CS-LBP_{R,N} = \sum_{i=0}^{(N/2)-1} s(z_i - z_{i+(N/2)})2^i$$

$$CS-LDP_{R,N} = \sum_{i=0}^{(N/2)-1} t[(z_i - z_c)\cdot(z_c - z_{i+(N/2)})]2^i$$

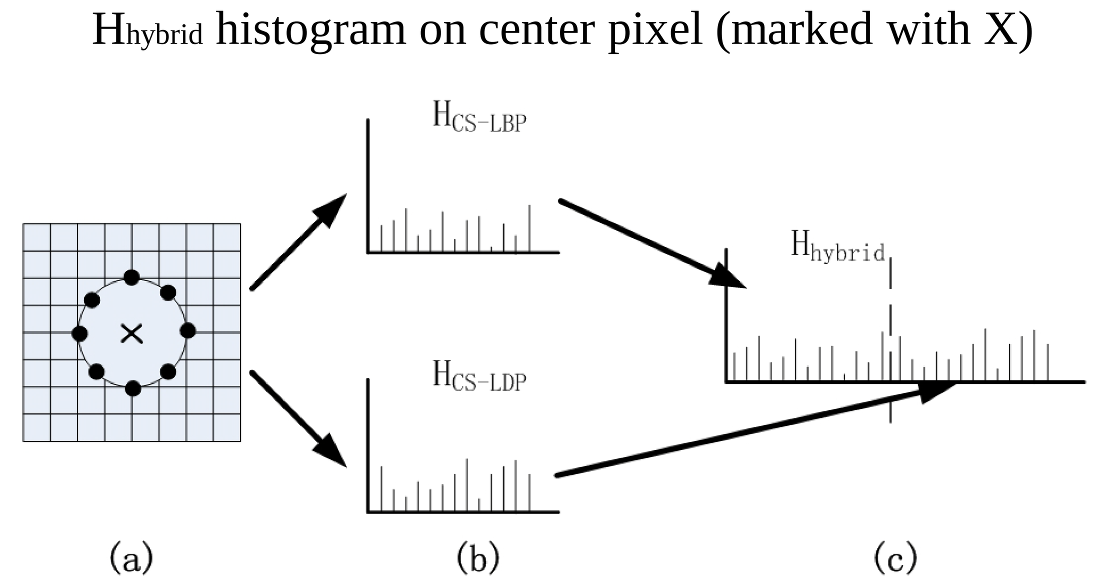
$$s(x) = \begin{cases} 1 & x \ge 0 \\ 0 & others \end{cases} \qquad t(x_1, x_2) = \begin{cases} 0 & x_1 \cdot x_2 > 0 \\ 1 & x_1 \cdot x_2 \le 0 \end{cases}$$

Given 8 neighbors:

LBP: 8 bits binary sequence
CS-LBP: 4 bits binary sequence
CS-LDP : 4 bits binary sequence

● New hybrid feature

H_{hybrid} histogram on center pixel (marked with X)



$$H_{hybrid} = H_{CS-LBP} \_\_ H_{CS-LDP}$$

Given N neighbors:

Histogram feature	Histogram bins
H_{LBP}	2^N
H_{CS-LBP}	$2^{N/2}$
H_{CS-LDP}	$2^{N/2}$
H_{hybrid}	$2*2^{N/2}$

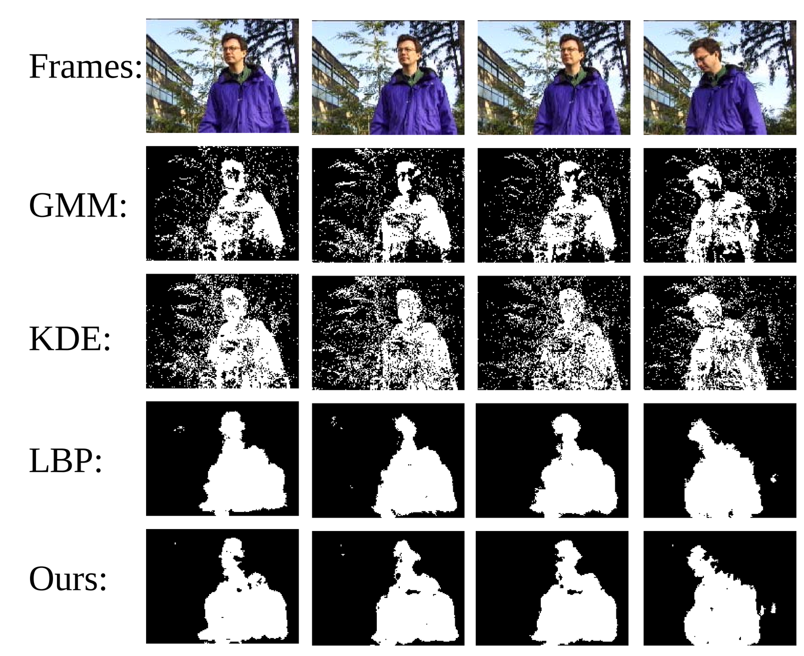
● Background subtraction method

Background Modeling
each pixel is built using a group of hybrid histograms
Model maintaining and foreground detection
For(*each pixel in current frame*) **do**
- *compute each pixel's hybrid feature*
- *compare it with the existing model features*

If (**matching condition is satisfied**)
Cur_Pixel = ***background***
update the most matching model feature and its weight
Else
Cur_Pixel = ***foreground***
model feature with lowest weight is replaced with the new feature and given to a initial weight
End
End

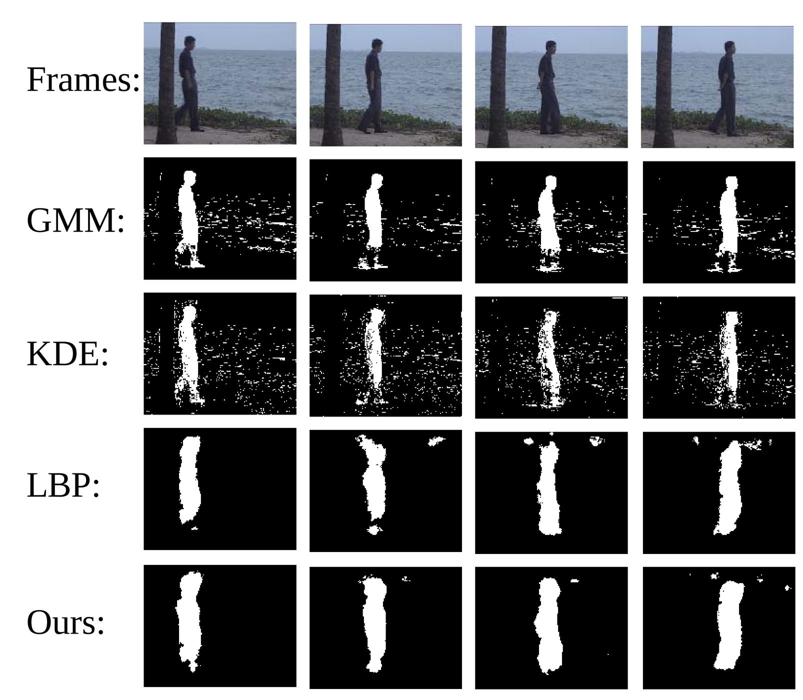
Results

Waving Trees



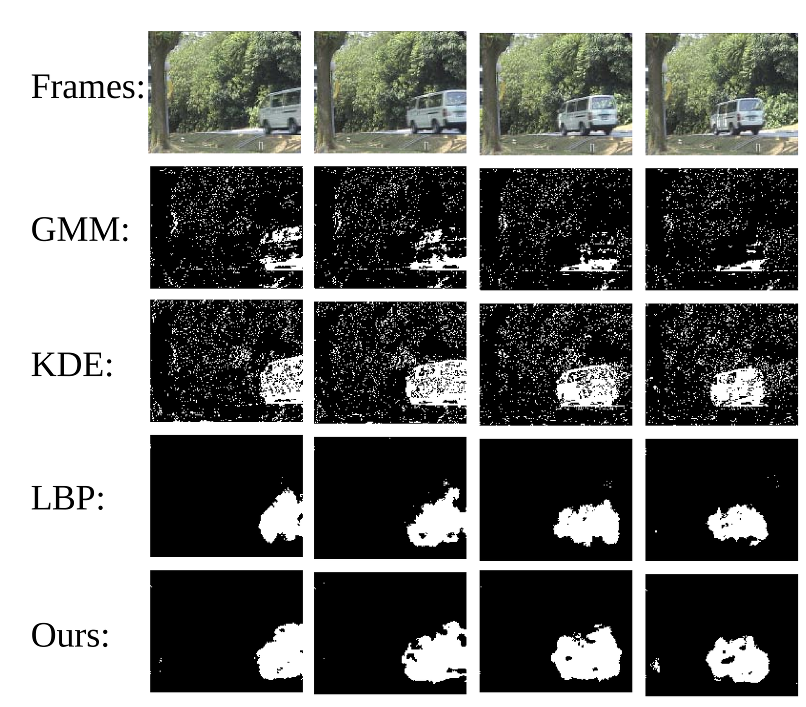
Method		GMM	KDE	LBP	Ours
Precision (%)	247th	75.44	71.01	92.47	90.32
	250th	70.69	66.64	94.78	91.88
	252th	75.73	70.65	92.35	90.84
	254th	80.19	77.56	95.00	93.50
Recall (%)	247th	64.04	79.88	87.99	88.09
	250th	61.49	72.36	85.66	88.52
	252th	63.07	70.95	88.57	89.44
	254th	64.35	75.25	88.86	89.05

Rippling Water



Method		GMM	KDE	LBP	Ours
Precision (%)	1498th	63.22	56.50	73.74	67.07
	1508th	75.17	56.50	62.42	64.87
	1514th	72.42	61.93	75.41	70.38
	1523th	71.63	63.02	67.31	63.41
Recall (%)	1498th	85.17	86.76	76.13	84.40
	1508th	76.68	70.16	69.96	80.30
	1514th	80.21	68.48	85.03	90.71
	1523th	82.83	70.13	85.10	86.28

Campus



Method		GMM	KDE	LBP	Ours
Precision (%)	1202th	39.74	43.19	88.82	77.09
	1204th	40.31	51.71	79.82	75.68
	1206th	31.14	48.11	87.61	71.00
	1208th	19.40	45.48	89.63	72.34
Recall (%)	1202th	44.54	78.14	85.06	92.75
	1204th	33.21	79.63	72.29	84.23
	1206th	23.79	77.93	86.45	92.14
	1208th	15.39	81.86	82.23	88.52

Speed Comparison

Method	Average running time per frame(second)		
	Waving Trees	Rippling Water	Campus
LBP	8.82	9.03	9.17
Ours	6.33	6.73	6.86
Time Reduction	28.23%	25.47%	25.19%

- **Adopting small feature set for background modeling saves the computation time.**
- **Not too much information is lost because high order local pattern can capture more detail information.**

Conclusions

- **Our method has low complexity and is robust to dynamic scenes.**
- **The combination of CS-LBP and CS-LDP operators may be effective in other research fields.**

Main References

1. Baochang Zhang, Yongsheng Gao, Sanqiang Zhao, and Jianzhuang Liu, "Local derivative pattern versus local binary pattern: face recognition with high-order local pattern descriptor," IEEE Trans. on Image Processing, vol. 19, no. 2, pp. 533–544, 2010.
2. Sanqiang Zhao, Yongsheng Gao, and Terry Caelli, "High-order circular derivative pattern for image representation and recognition," Proc. 20th International Conference on Pattern Recognition, pp. 2246–2249, 2010.