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Extended Local Binary Pattern Fusion For Face Recognition

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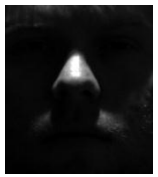
The Face Recognition Problem



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Remains A Challenging Problem

- Large and uncertain class number
- The presence of large *intraclass* variations:
  - Illumination variations
  - Pose variations
  - Expression variations
  - Occlusions
  - Age variations
  - ……
- The demands of robust and accurate face recognition system

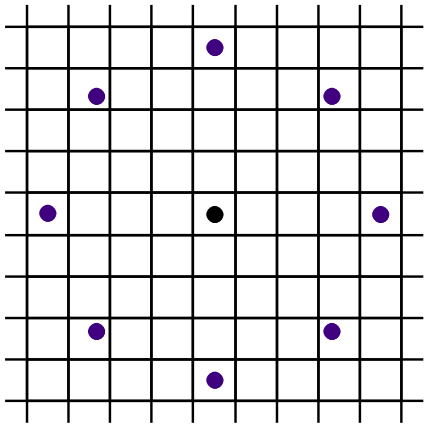
Background and Related Work

- Local feature descriptors for face recognition have attracted increasing attention.
- LBP has emerged as one of the most prominent face analysis methods:
  - LBP → ECCV, 2004
  - LGBPHS → ICCV, 2005
  - HGPP → TIP, 2007
  - POEM → TIP, 2012
  - LQP → BMVC, 2012
  - DFD → TPAMI, 2014

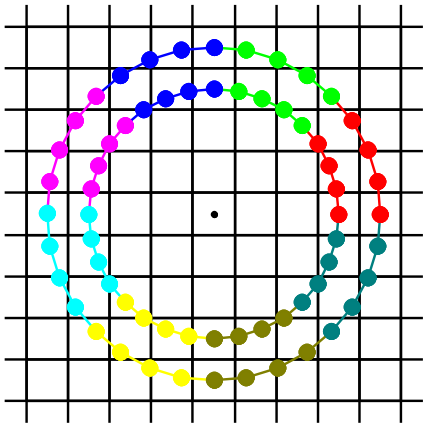
Motivations

- LBP encodes only the pairwise intensity relationships between a pixel and its neighbors.
- We intend to exploit complementary information contained by pairwise pixel comparisons between neighbors of a pixel.
- We want to further obtain more powerful feature by combining multiple LBP-like descriptors.
- We are motivated by our recent work on texture classification, where four powerful LBP-like descriptors werepresented.

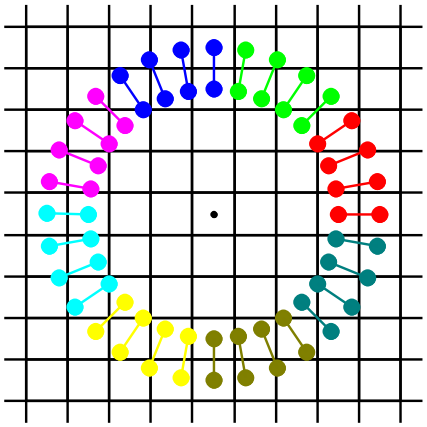
Simple Local Features for Deriving LBP-like Descriptors



(a) Local Intensities

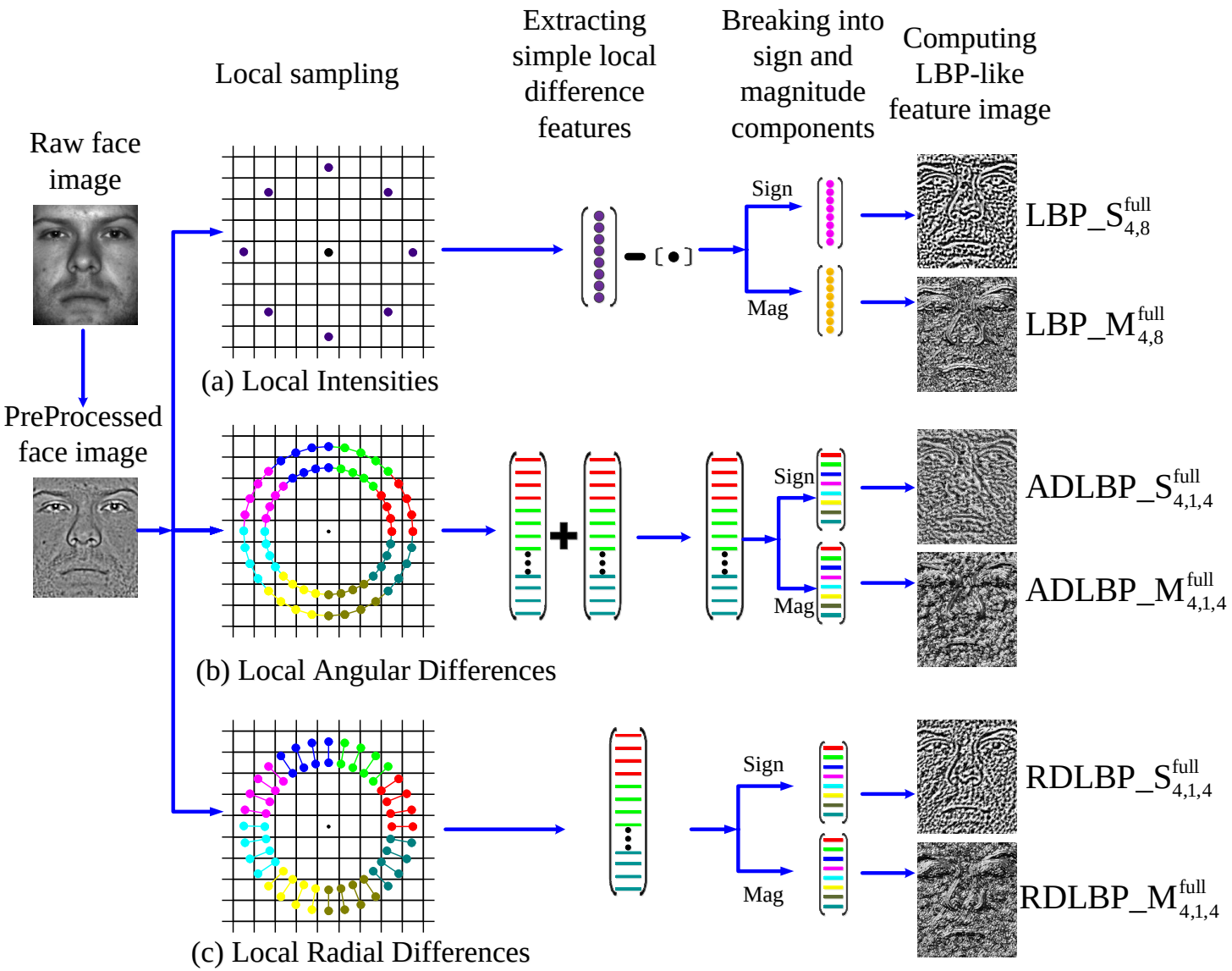


(b) Angular Differences (AD)

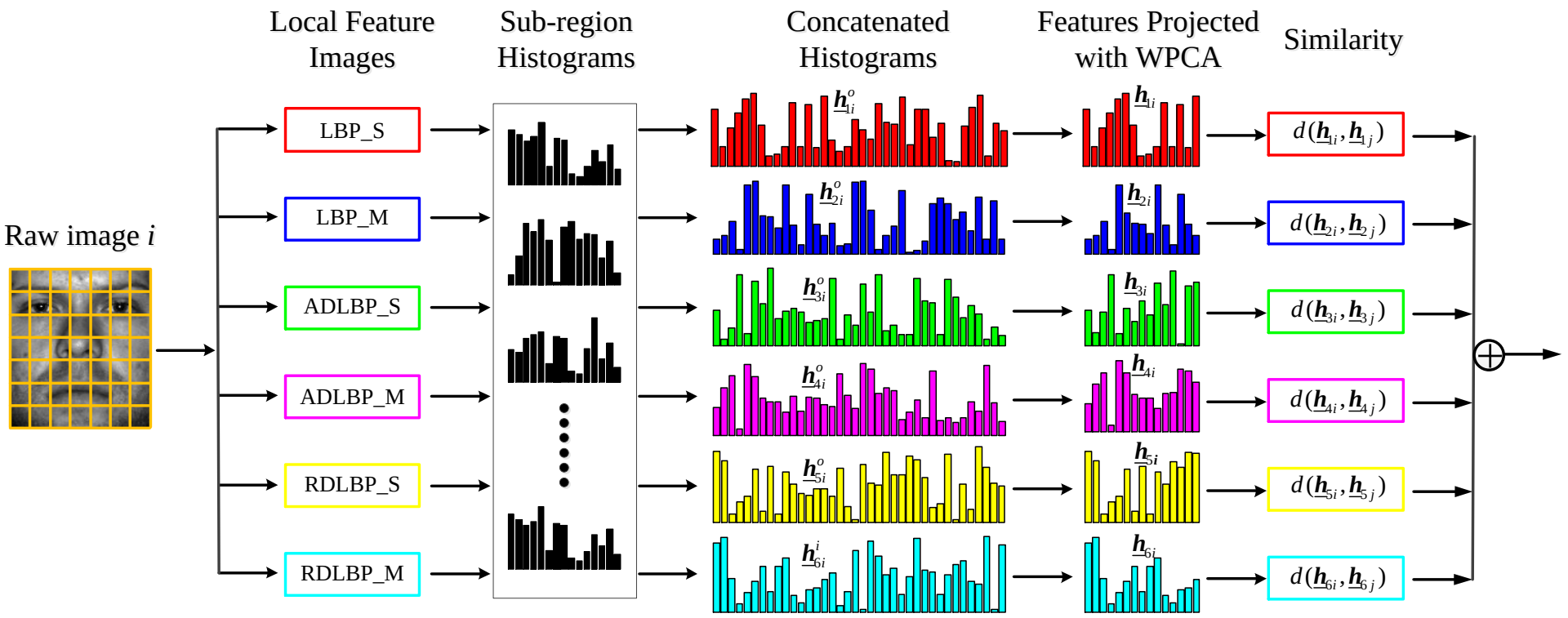


(c) Radial Differences (RD)

Proposed Extended Set of LBP



Overview of the Proposed Face Recognition Framework



ELBP includes: LBP_S, LBP_M, ADLBP_S, ADLBP_M, RDLBP_S, RDLBP_M

WPCA: Whitened PCA

Experimental Data: Extended Yale B

- Number of subjects: 38
- Number of samples per subject: 64
- Divided into five subsets:
  - S1→7 Images per subject, Normal lighting, Gallery
  - S2→12 Images per subject, Slight illumination variations, Probe
  - S3→14 Images per subject, Moderate illumination variations, Probe
  - S4→12 Images per subject, Severe illumination variations, Probe
  - S5→19 Images per subject, Severe illumination variations, Probe

Experimental Data: Extended Yale B

S1 (Gallery)

S2 (Probe)

S3 (Probe)

Experimental Data: Extended Yale B

S4 (Probe)

S5 (Probe)

Experimental Data: CAS-PEAL-R1

- Number of subjects: 1040
- Number of samples in total: 30863

Function	Dataset	#Subjects	#Images
Gallery	Gallery	1040	1040
Probe	Expression	377	1570
Probe	Accessary	438	2285
Probe	Lighting	233	2243

Experimental Data: CAS-PEAL-R1

Cropped face examples from CAS-PEAL-R1

Experimental Results: Extended Yale B

NNC classifier
Chi Square distance

Method	S2	S3	S4	S5	Mean
LBP_S^{u2}	99.8	99.6	93.2	77.7	92.6
LBP_M^{u2}	99.8	99.2	95.8	91.7	96.6
ADLBP_S^{u2}	99.8	89.5	28.5	12.5	57.6
ADLBP_M^{u2}	99.8	99.6	94.5	88.7	95.7
RDLBP_S^{u2}	99.8	99.4	91.9	68.5	89.9
RDLBP_M^{u2}	**99.8**	**99.6**	**98.2**	**91.5**	**97.3**
LBP_S^{full}	99.8	99.8	99.6	96.2	98.9
LBP_M^{full}	**99.8**	**99.6**	**99.6**	**97.6**	**99.2**
ADLBP_S^{full}	99.8	99.6	91.4	67.1	89.5
ADLBP_M^{full}	**99.8**	**99.6**	**99.4**	**97.8**	**99.2**
RDLBP_S^{full}	99.8	99.6	98.7	86.6	96.2
RDLBP_M^{full}	99.8	99.6	98.9	95.7	98.5
PCA [18]	98.5	80.0	15.8	24.4	54.7
LRC [18]	100	100	83.27	33.61	79.2
LRC_Fused [19]	100	100	88.97	84.73	93.4

Experimental Results: CAS-PEAL-R1

WPCA
NNC classifier
Euclidean distance

Method	Expression	Accessary	Lighting
LBP_S^{full}+WPCA	97.5	92.4	42.9
LBP_M^{full}+WPCA	94.1	85.1	36.5
ADLBP_S^{full}+WPCA	98.1	93.6	47.0
ADLBP_M^{full}+WPCA	95.1	87.0	42.1
RDLBP_S^{full}+WPCA	96.1	90.5	33.1
RDLBP_M^{full}+WPCA	91.3	78.1	34.8
ELBP_Fused	98.5	93.8	66.2
ELBP_Fused $(*)$	98.5	94.0	**72.3**
HGPP [4]	96.8	92.5	62.9
DT-LBP [20]	98.0	92.0	41.0
DLBP [21]	**99.0**	92.0	41.0
DFD+WPCA [7]	**99.0**	**96.9**	63.9

Conclusions

- The proposed extended set of LBP-like descriptors capture complementary information;

- The WPCA technique can further improve the recognition performance of the fused proposed features.

- The proposed fused ELBP approach is highly robust to illumination variations.

Thank you!

I will be glad to answer your questions.