CONTOUR COVARIANCE: A FAST DESCRIPTOR FOR CLASSIFICATION

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Introduction

Fig. 1: two butterflies of one class & two leaves from different cultivars, indicating large intra-class variations and small inter-class variations.

Research Gap.

1. Separate use of contour or region features may fail to function in the very challenging cultivar-level leaf classification and butterfly classification.
2. Combined use of contour and region require high feature dimensionality and large training datasets.

Motivation.

How to efficiently and effectively classify the shapes via integral of both contour and region features.

Contributions

- We propose a novel contour covariance (CC) descriptor to characterize covariance features for shape classification.
- The proposed CC descriptor is compact yet informative, as well as invariant to scale, rotation and translation.
- The experimental results on Leaf & Butterfly datasets demonstrate the effectiveness and efficiency of the proposed method.

Method

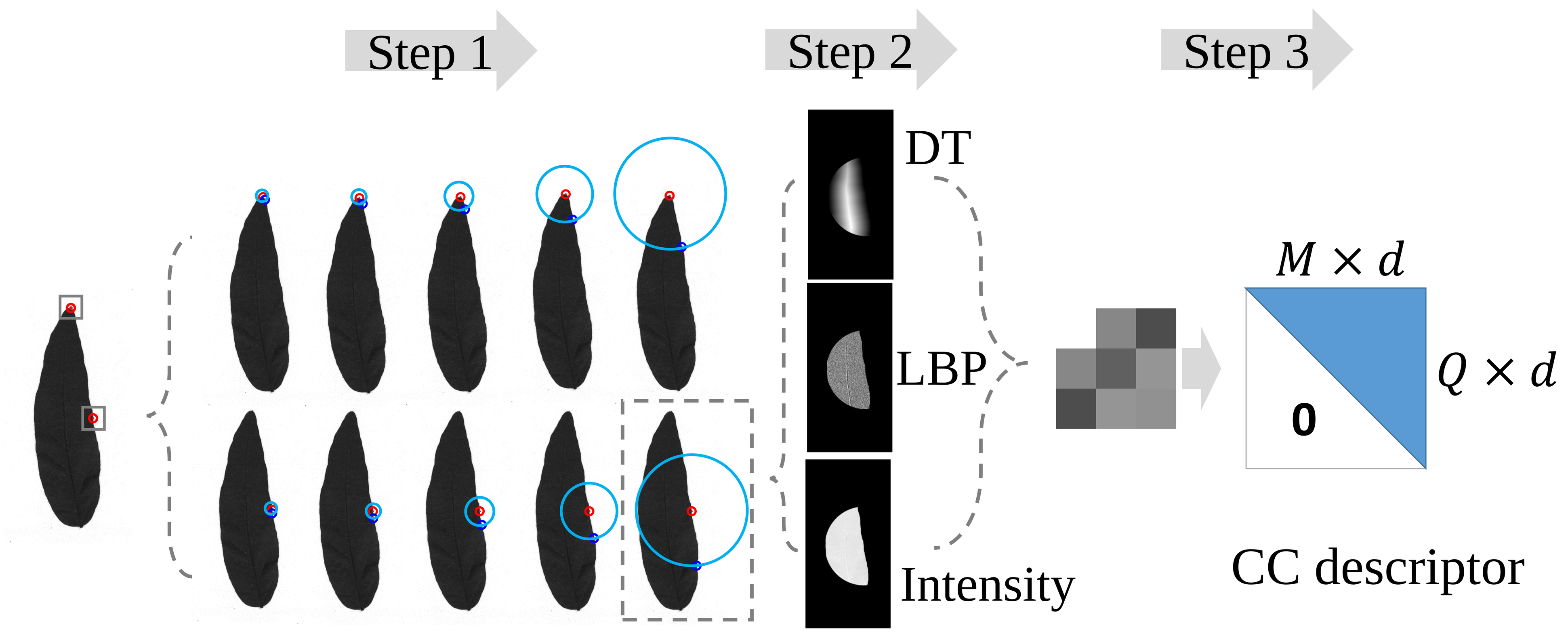

Fig. 2: An overview of the proposed method

- **Step 1**: determine contour regions under multiple scales.
- **Step 2**: calculate covariance matrices using Distance Transform (DT), LBP, and intensity in determined regions.
- **Step 3**: construct the CC descriptor using coefficients of the calculated covariance matrices.

Discussions

- **Efficiency**: The proposed CC descriptor enables a matrix form feature representation for shape description and a fast Minkowski metric for shape matching.
- **Effectiveness**: Both contour and region features are integrated in a multiscale manner for discriminative shape description.

Experimental Results

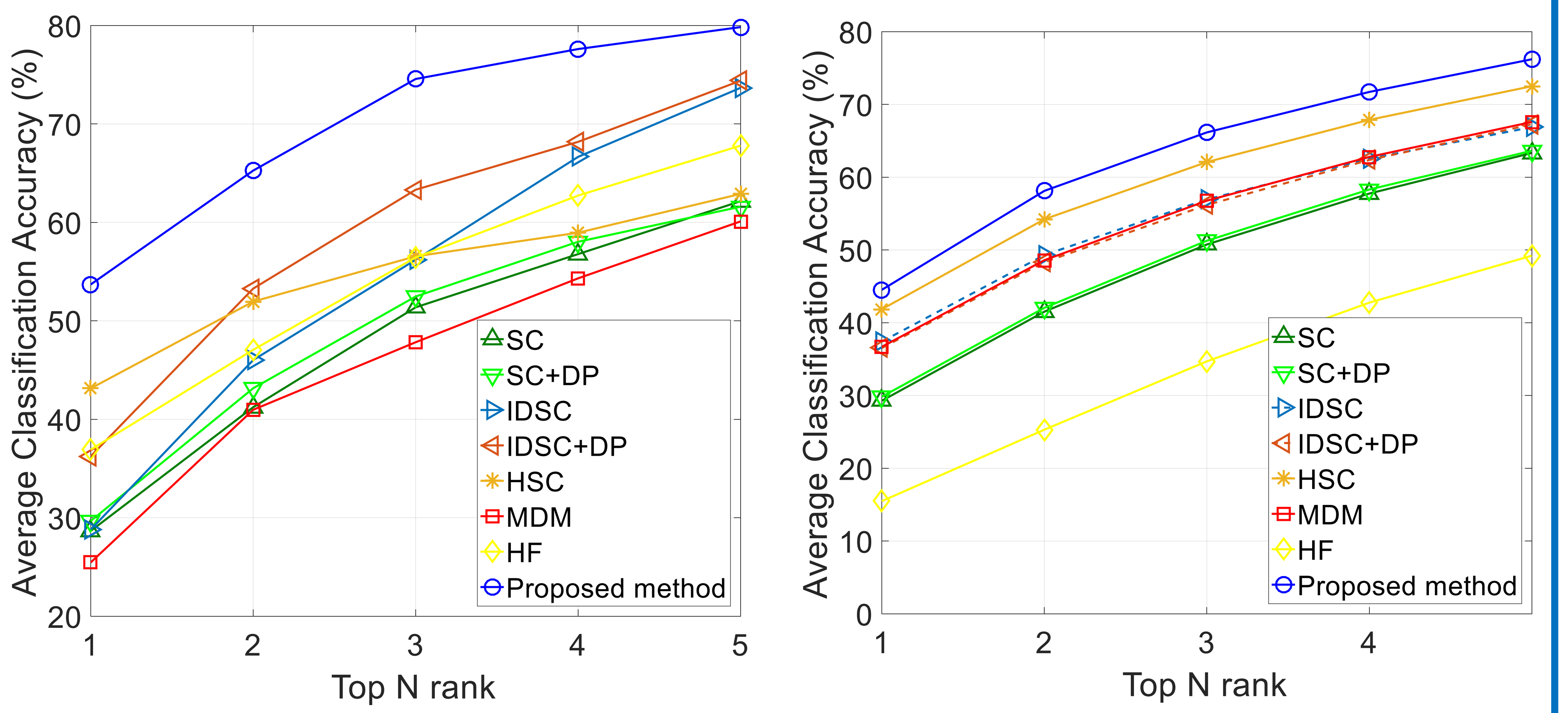

Fig. 3. CMC curve on Leaf & Butterfly datasets

Algorithm	Matching time (ms)	
	Leaf	Butterfly
SC (TPAMI 2002)	2.90×10^{0}	3.00×10^{0}
SC+DP (TPAMI 2002)	1.51×10^{-1}	1.08×10^{-1}
IDSC (TPAMI 2007)	1.90×10^{0}	2.10×10^{1}
IDSC+DP (TPAMI 2007)	1.11×10^{-1}	1.13×10^{-1}
HSC (TIP 2014)	9.70×10^{-3}	8.10×10^{-3}
MDM (TIP 2012)	6.77×10^{-2}	5.00×10^{-2}
HF (PRL 2012)	1.17×10^{1}	8.50×10^{1}
Proposed method	$\mathbf{6.62\times10^{-2}}$	$\mathbf{5.81\times10^{-2}}$

Table 1. Matching time on Leaf & Butterfly datasets

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