CONTOUR COVARIANCE: A FAST DESCRIPTOR FOR CLASSIFICATION

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\section*{Introduction}

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

\section*{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.

\section*{Motivation.}

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

\section*{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.

\section*{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.

\section*{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.

\section*{Experimental Results}

Table 1. Matching time on Leaf & Butterfly datasets

<table>
<thead>
<tr>
<th>Algorithm</th>
<th>Matching time (ms)</th>
</tr>
</thead>
<tbody>
<tr>
<td>SC (TPAMI 2002)</td>
<td>2.90×10\textsuperscript{0}</td>
</tr>
<tr>
<td>SC+DP (TPAMI 2002)</td>
<td>1.51×10\textsuperscript{1}</td>
</tr>
<tr>
<td>IDSC (TPAMI 2007)</td>
<td>1.90×10\textsuperscript{0}</td>
</tr>
<tr>
<td>IDSC+DP (TPAMI 2007)</td>
<td>1.11×10\textsuperscript{1}</td>
</tr>
<tr>
<td>HSC (TIP 2014)</td>
<td>9.70×10\textsuperscript{-3}</td>
</tr>
<tr>
<td>MDM (TIP 2012)</td>
<td>6.77×10\textsuperscript{-2}</td>
</tr>
<tr>
<td>HF (PRL 2012)</td>
<td>1.17×10\textsuperscript{1}</td>
</tr>
<tr>
<td>Proposed method</td>
<td>6.62×10\textsuperscript{-2}</td>
</tr>
</tbody>
</table>

Fig. 3. CMC curve on Leaf & Butterfly datasets

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