GENDER RECOGNITION FROM FACIAL IMAGES USING LOCAL GRADIENT FEATURE DESCRIPTORS

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OUTLINE

• Contributions

• Gender Recognition Methods
  • Face Detection
  • Local Gradient Feature Descriptors
  • Classifier Method

• Experimental Settings and Results

• Conclusion
Contributions

• We proposed two well-known local gradient feature descriptors
  • *Histogram of Oriented Gradients (HOG)*
  • *Scale-Invariant Feature Transform (SIFT)*

• The gradient feature descriptor combined with the *Support Vector Machine (SVM) with the Radial Basis Function (RBF)*
Gender Recognition Methods

• Face Detection: *Haar-Cascade Classifier*
• Local Gradient Feature Descriptors: *HOG and SIFT*
• Classifier Method: *SVM with RBF Kernel*

- HOG: \[ 0.123, 0.345, \ldots, 0.999 \]
- SIFT: \[ 0.224, 0.134, \ldots, 0.999 \]
Experimental Settings and Results

- We will describe;
  - The *face image dataset* used in the experiments
  - The experimental results consisting of
    - *The face detection results*
    - *Parameter settings*
    - *Grid search parameter estimation*
    - *Gender recognition results*
Face image dataset

• We used a benchmark face image dataset, called *the color face recognition technology (ColorFERET) dataset*.
  • Firstly, we used ColorFERET for *face detection* purpose.
  • Secondly, we divided the ColorFERET dataset using *2-fold (50:50) and 10-fold (90:10)*.
Face image dataset

• The ColorFERET dataset consists of 14,126 face images from 1,199 subjects.
• The resolution of images in the dataset is $384\times256$ pixels.
Face image dataset

• In the ColorFERET dataset, there are **13 different poses** of each person, such as regular frontal image, profile left, half left, quarter left and also head turned
Experimental results

• Face Detection Result:

\[ Acc_{fd} = Ac_{fd} - Er_{fd} \]

when

\[ Ac_{fd} = \frac{c \times 100}{N} \]

where

- \( c \): The number of face images, after using a face detection technique
- \( e \): The number of the error face images
- \( N \): The total number of the face images in the dataset
Experimental results

- **Face Detection Result:** The Haar-Cascade classifier obtained an accuracy of **39.25%**.
- The accuracy of the male and female faces was 36.87% and 41.63%, respectively.

<table>
<thead>
<tr>
<th>Gender</th>
<th>Number of male images</th>
<th>Number of face detected</th>
<th>Number of error detected</th>
</tr>
</thead>
<tbody>
<tr>
<td>Male</td>
<td>7,139</td>
<td>2,854</td>
<td>222</td>
</tr>
<tr>
<td>Female</td>
<td>3,980</td>
<td>1,770</td>
<td>113</td>
</tr>
</tbody>
</table>
Experimental results

• Face Detection Result:
Parameter settings

- The best parameters of *HOG descriptor* used 9 orientations, 8 pixels per cell, and 3 cells per block.
Parameter settings

- The best parameters of SIFT descriptor used:
  - Patch size = 25 pixels

**TABLE III. THE PERFORMANCE OF THE SIFT DESCRIPTOR USING DIFFERENCE PATCH SIZES**

<table>
<thead>
<tr>
<th>SIFT Descriptor Parameters</th>
<th>Patch sizes</th>
<th>Accuracy (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>10</td>
<td>97.8</td>
</tr>
<tr>
<td></td>
<td>20</td>
<td>98.2</td>
</tr>
<tr>
<td></td>
<td><strong>25</strong></td>
<td><strong>98.4</strong></td>
</tr>
<tr>
<td></td>
<td>30</td>
<td>97.1</td>
</tr>
<tr>
<td></td>
<td>40</td>
<td>97.1</td>
</tr>
<tr>
<td></td>
<td>45</td>
<td>97.8</td>
</tr>
<tr>
<td></td>
<td>50</td>
<td>96.9</td>
</tr>
</tbody>
</table>
Grid search parameter estimation

- We have optimized the hyper-parameters of the SVM classifier with the RBF Kernel using \textit{grid-search method}.
- We searched the hyper-parameter \( C \) and \textit{gamma} between the number of \( 2^{-7} \) and \( 2^7 \).

**TABLE IV. **The best hyper-parameter values for the SVM classifier with the RBF kernel

<table>
<thead>
<tr>
<th>Methods</th>
<th>( C )</th>
<th>( \gamma )</th>
</tr>
</thead>
<tbody>
<tr>
<td>HOG</td>
<td>( 2^3 )</td>
<td>( 2^0 )</td>
</tr>
<tr>
<td>SIFT</td>
<td>( 2^3 )</td>
<td>( 2^{-5} )</td>
</tr>
</tbody>
</table>
Gender recognition results

- From the face detection result, we divided \textbf{4,624 face images} into train and test sets with the ratio of \textbf{50:50 (2-cv) and 90:10 (10-cv)}. 

<table>
<thead>
<tr>
<th>Methods</th>
<th>Accuracy (%)</th>
<th>2-cv</th>
<th>10-cv</th>
</tr>
</thead>
<tbody>
<tr>
<td>HOG</td>
<td></td>
<td>96.50 ± 1.8</td>
<td>98.75 ± 2.5</td>
</tr>
<tr>
<td>SIFT</td>
<td></td>
<td>95.98 ± 0.4</td>
<td>99.20 ± 0.8</td>
</tr>
</tbody>
</table>
Conclusion

• The main objective of this paper is to recognize gender (male and female) from facial images.

• **First**, the Haar-cascade classifier was used to find the face from the whole image.

• **Second**, the face images were then assigned to the local gradient feature descriptors (HOG and SIFT) to compute the feature vector.
Conclusion

• **Finally**, for gender recognition, the invariant feature vector was classified using SVM with the RBF kernel.

• **The SIFT descriptor** outperformed the HOG descriptor when combined with *SVM with the RBF kernel*.

• This method obtained **very high recognition accuracy**.
Acknowledgement

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THANK YOU FOR YOUR ATTENTION

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