Analysis of most important parts for silhouette-based gait recognition

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Abstract:
Many silhouettes based features are proposed for gait recognition. But these methods suffer with covariate factors such as clothing and carrying objects. These covariate factors mostly attached with silhouettes and make gait recognition much difficult. Therefore we proposed a new silhouette based feature to analyse the influence of body parts and increase the recognition rate for individual identification.

Problem:
Performance of Gait Recognition under different Covariate Conditions:
- Gait recognition is recognizing people by the way they walk.
- Gait recognition is non intrusive
- Operates at a distance without subject cooperation.

Covariate conditions?:
- Conditions that effect gait.
- Can be divided into two categories
  1) Effecting features extracted from gait
     - Carrying Condition, Clothing Condition, View etc
  2) Effecting gait itself
     - Shows, Time, Injury, Speed etc

Existing appearance-based works:
- Even though these gait feature representations show good recognition rate, their average recognition rates are not that promising (i.e. less than 75%).
- This indicates that a more robust appearance-based gait feature representation is needed.
- Also, Li et al. [1] segmented the human silhouette into seven components, namely head, arm, trunk, thigh, frontleg, back-leg, and feet. They showed that removal of certain body decrease the recognition rate, e.g. head and also removal of some parts increased the recognition rate, e.g. thigh.

Our Solution:
- Parts structure based GEI (PRWGEI).
- Apply Poisson Random Walk approach to binary silhouette.
- Extract various properties of shape analysis

Poisson Equation

\[ U(x, y) \text{ can be computed recursively as follows:} \]
\[ U(x, y) = \frac{1}{4} (U(x+1, y) + U(x-1, y)) \]
\[ + U(x, y+1) + U(x, y-1) + 1 \quad \text{(1)} \]

Note that (1) is a discrete form approximation of the Poisson equation [2]:
\[ \Delta U(x, y) = -\frac{4}{h^2} \]

Recognition:
- The PCA+LDA is applied to reduce the dimension of the data and also to improve the discriminative power of the extracted features.
- Then the k-nearest neighbour (k-NN) is applied to classify the data and make a decision, i.e. decide the identity of a person.

Results:
- 124 individuals with normal(6), carrying(2) and clothing(2) conditions.
- training: 124 individuals with normal(2) – CasiaSetA2, carrying(2) – CasiaSetB and clothing(2) – CasiaSetC

PERFORMANCE ON CASIA-B (COVARIATE) DATASET

<table>
<thead>
<tr>
<th>( \theta )</th>
<th>130</th>
<th>140</th>
<th>150</th>
<th>160</th>
<th>170</th>
<th>180</th>
</tr>
</thead>
<tbody>
<tr>
<td>CasiaSetA2</td>
<td>98.0%</td>
<td>98.0%</td>
<td>98.0%</td>
<td>98.4%</td>
<td>98.3%</td>
<td>98.3%</td>
</tr>
<tr>
<td>CasiaSetB</td>
<td>86.3%</td>
<td>86.3%</td>
<td>90.0%</td>
<td>91.1%</td>
<td>92.3%</td>
<td>88.9%</td>
</tr>
<tr>
<td>CasiaSetC</td>
<td>42.3%</td>
<td>39.1%</td>
<td>37.9%</td>
<td>44.4%</td>
<td>44.0%</td>
<td>44.3%</td>
</tr>
<tr>
<td>Average</td>
<td>75.6%</td>
<td>74.4%</td>
<td>75.3%</td>
<td>78.6%</td>
<td>78.2%</td>
<td>77.3%</td>
</tr>
</tbody>
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Conclusion:
- Gait Energy Image representation based on Poisson random walk approach
- Our proposed novel gait features provide better results for person identification with CASIA-B dataset.
- As a future direction, we would like to test our method with dataset such as USF dataset and SOTON dataset.
- In addition, further research can be done to find a robust analytical solution to identify the optimal value for \( \theta \).

References: