Fine-tuning approach to NIR face recognition

Introduction

Motivation

- Due to the active NIR lights, the intensity of the NIR face image changes very slightly in the poor light conditions.
- In addition, face recognition (FR) using NIR images is robust to spoofing attack\(^1\).
- Despite these advantages of NIR FR, the performance of NIR FR is not high enough because the number of training data is relatively limited compared to that of RGB data.
- Our goal is to overcome this problem by adapting the fine-tuning approach to NIR FR.

Overall Process of NIR FR

- The pair of two face images is inputted into the deep CNN model for NIR FR.
- Positive pair: same person
- Negative pair: different person
- The model recognizes whether two face images in the input pair are the same person.

Proposed Fine-tuning Approach

Training Deep CNN Model for NIR FR

- Pre-trained RGB model
- Deep features
- NIR deep CNN model
- Deep features
- Loss
- Backpropagation

Validity of Pre-trained RGB Model

- From the similarity of the activations, we can expect that the parameters of both models for RGB and NIR FR are highly similar.
- Therefore, the NIR deep CNN model can be trained effectively by utilizing the parameters of the pre-trained model.

Construction of Private Face database

- We constructed the private NIR and RGB face database to compare the performance of NIR and RGB FR in poor lighting conditions.

Experimental Results

Performance on Public NIR Face Database

- Inception-Resnet-v1 and VGGNet-16 achieved more than 99% performance on the most public NIR face databases.

Comparison with RGB FR

- The performances of the proposed fine-tuning approach and RGB FR in the real-world FR scenario.

<table>
<thead>
<tr>
<th>Method</th>
<th>Accuracy(%)</th>
<th>Validation rate(%)</th>
<th>FAR(%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>NIR FR(\d)</td>
<td>96.88</td>
<td>94.47</td>
<td>0.7</td>
</tr>
<tr>
<td>RGB FR</td>
<td>71.35</td>
<td>100.00</td>
<td>57.30</td>
</tr>
</tbody>
</table>

* NIR FR indicates the proposed fine-tuning approach.

- The performances of the proposed fine-tuning approach and RGB FR in the poor lighting conditions.

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<th>Validation rate(%)</th>
<th>FAR(%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>NIR FR(\d)</td>
<td>96.65</td>
<td>84.90</td>
<td>0.1%</td>
</tr>
<tr>
<td>RGB FR</td>
<td>86.50</td>
<td>44.03</td>
<td>0.1%</td>
</tr>
</tbody>
</table>

Comparison with Existing Methods

<table>
<thead>
<tr>
<th>NIR FR methods</th>
<th>Identification rate(%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Zhang et al. [14]</td>
<td>90.89</td>
</tr>
<tr>
<td>Peng et al. [15]</td>
<td>88.65</td>
</tr>
<tr>
<td>Fine-tuning (VGG-16)</td>
<td>98.15</td>
</tr>
<tr>
<td>Fine-tuning (Inception-Resnet-v1)</td>
<td>97.22</td>
</tr>
<tr>
<td>Fine-tuning (Inception-Resnet-v2)</td>
<td>99.67</td>
</tr>
</tbody>
</table>

Conclusion

- We showed the validity of the proposed fine-tuning approach from the similarity between the pre-trained RGB model and the NIR deep CNN model.
- High performance of the proposed approach was achieved.
- In the future, we will focus on alleviating the sensor dependency of NIR FR.