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論 文 要 旨

THESIS SUMMARY

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要旨（英文 800 語程度）
Thesis Summary（approx.800 English Words ）

Human face is an advantageous biological trait for individual identification. In recent years, face detection and recognition have been widely exploited in various application areas. Although great advances have emerged for their real applications under different conditions, they still suffer from some performance limitations caused by specific uncontrolled factors. Among these factors, the negative influence of illumination is a key problem. This dissertation deeply investigates the illumination problem in face detection and recognition. Overcoming the negative effects from varying illumination on the performance of face detection and recognition is the key focus.

Chapter 1 gives the general introduction. It defines the illumination problem, presents our motivation to tackle this problem, shows the objectives of our research with the corresponding approaches, lists the main contributions of this research, and finally explains the organization of this dissertation.

In Chapter 2, we discuss related works including the prominent algorithms generally proposed for face detection & recognition tasks and the representative approaches specially developed for addressing the illumination problem.

In Chapter 3, we study how much the prepended normalization step could affect the pre-trained face detectors by combining the normalization and two famous learning-based face detectors. The applications of normalization to face detection have not been widely studied in the literature. We apply a number of existing normalization techniques under this framework. They were initially proposed for different purposes (face recognition or image enhancement) rather than face detection. We also proposed a novel image normalization method Segmentation-based Histogram Stretching and Truncation (SH) for the purpose of enhancing the local contrast (facial structures) and removing the negative effects from non-uniform illumination for face detection. We observe that several used normalization techniques can largely improve the correct detection of the original face detectors, which demonstrates the effectiveness of using specific normalization methods. Our method yields the best performance in terms of F-measure, which verifies its advantages in suppressing the illumination and preserving intrinsic facial features. We also reach an interesting conclusion that useful normalization techniques for face recognition or image enhancement are not necessarily effective for face detection with face detector pre-trained by using normal training samples. But unfortunately, SH may sacrifice some details of the image for better local enhancement and this leads to false negatives in some cases.

In Chapter 4, in order to address the limitations of a recently proposed face representation method Weberface (WF) for illumination insensitive face recognition, we propose to improve it in two ways. One is to incorporate the oriented information into the final face representation by concatenating eight directional face images rather than simply summing them together. Thus we name this method oriented Weberface (OWF). These images are computed based on the Weber's law, similar to the conventional WF. Another improvement ia achieved by characterizing the facial features in larger granularities and was called largely-scaled Weberfaces (LSWFs). This is based on the fact that the local changes may not mean those in the nearest neighborhood. Both of these improvements can result in face representations related to only the reflectance component R according to the Lambertian reflectance model, which theoretically proved their insensitivity to varying illumination. We compare the recognition performance using our methods with several other well-known methods. The benchmarked results illustrate that our methods significantly outperform the others. However, the computational cost and memory cost of OWF are rather high and how to combine each of the advantages of our methods remains unsolved.

In Chapter 5, we propose another illumination insensitive face representation method using multifractal analysis, named Mulrifractal-Face (MFF). Multifractal analysis is a popular tool to derive feature descriptors for a variety of image processing purposes. In our method, the $f(\alpha)$ features are computed from the given image as the representation for the subsequent face recognition. Our method directly extracts the illumination insensitive features from each given image and thus is effective for extensive implementations. We also analyze its discrimination capacity and insensitivity to illumination variances theoretically. Its core merit is the ability of coding the local and global image regularity. The usage of this ability was inspired from the illumination property. The experimental results showed that MFF was more powerful in achieving a balance between illumination insensitivity and discriminative ability for face classification than several other state-of-the-art methods. However, there leaves room for further improvement of the illumination insensitivity of our method.

Apart from the above particular methods proposed for tackling the illumination problem, we also did a survey on the illumination processing in face recognition in Chapter 6. We found that most of the existing surveys of this topic lack the emphasis on important aspects which are noteworthy for the upcoming researchers to construct new algorithms. To fill this gap, we summarized and discussed some issues from several perspectives. Studying along these issues may assist to improve the face recognition performance under varying illumination. Our survey played just such an enlightening role. The summative evaluations through some experiments were given as well.

Chapter 7 concludes the whole dissertation. It summarizes the content of each chapter and also points out the limitation and further work.