別紙様式８

研　究　主　論　文　抄　録

論文題目

Pose Invariant Face Recognition Using Dominant Frequency Based Holistic Features and Statistical Classifier

（全体的特徴と統計的識別器に基づく主要周波数を用いた姿勢に不変な顔認識）

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主論文要旨

《本文》The idea of face recognition was inspired by ability of human being to recognize object or pattern based on training that has been performed continuously since childhood. Some researchers adopted that process to create any kinds of recognition systems, such as recognition system based on geometrical analysis, statistical analysis, neural network, etc. The face recognition is one of the most active research areas in pattern recognition, not only because the face is a human biometric characteristics of human being but also because there are many potential applications of the face recognition that range from human-computer interactions to authentication, security, and surveillance.

The published methods of face recognition can be categorized in to three groups (Zhao et . all, 2003). Firstly holistic matching method, which uses the whole face region as raw input to the recognition system; secondly features based (structural) matching methods which use the local features such as the eyes, noses, and mouth, and local statistics (geometrics and or appearance) as data input to the recognition system; and thirdly hybrid methods which use both whole face and local features as data input to the system. The PCA-based and LDA-based methods of face recognition that belong to the first category are well known and encouraging results have been achieved. However, both of them have their limitations: large computational costs, high memory space requirement, and retraining problems. In addition, the main disadvantage is the PCA projected features are lack of discrimination power because it removes the null spaces of data scatter that have the discriminant information.

This dissertation presents an approach to pose invariant human face image recognition. The proposed scheme is based on the analysis of discrete cosine transforms (DCT), discrete wavelet transforms (DWT), and moment analysis as global features extraction of face images. In detail, our proposed methods can be categorized as written below:

1. Dominant frequency features based face recognition. The scheme of this method is based on

frequency analysis to obtain the features of face image and multi-resolution metric to determine the similarity among the query face features and the training face features set. There are two main aims of the proposed method: to create holistic compact and meaningful features of face image without removing significant face image information, and to build a simple training algorithm that can solve the retraining problem of PCA-based face recognition. The proposed holistic features of face image are obtained by frequency analysis and quantization. The quantization will make that the features is not sensitive to small lighting variations.

2. Hybrid dominant frequency features based face recognition. The previous work still lack of discriminant power, which is shown by success rate still far from the maximum. It means the single frequency analysis is not adequately enough yet to represent the holistic information of any face pose variations. To address this problem, we propose an improvement of pose invariant human face recognition approach based on the analysis of the DCT and multi level Discrete Wavelet Transforms (DWT) of the face images. From both the DCT and DWT domain coefficients, which describe the face information, are fused as compact and meaningful features vector, using simple statistical measures and quantization called as the hybrid dominant frequency features. The main objective of the proposed method is to improve our previous method performance in term of recognition rate.

3. Statistical based face recognition. In order to improve the performance of our previous face recognition, we propose an features cluster which is derived from maximum a posteriori (MAP) discriminant called as modified LDA (MLDA). However, the propose features cluster does not works on using quantized dominant frequency features because that features make the global covariance be singular. Therefore, we implements non quantized dominant frequency features. In this case, the MLDA is introduced to performed multi-pose face features cluster. There are several objectives of our proposed method. Firstly, to redefine our previous compact and meaningful face feature without removing significant face image information. Secondly, to build a simple classification technique that can classify face images to person's classes well. Thirdly, to make the MLDA-based training system that can solve the retraining problem. Finally, to know the effectiveness of DCT and wavelet analysis as face feature extraction when they are combined with the MLDA based classification.

4. Real-time face recognition using predictive LDA and alternative PCA. Previously, the global/holistic feature of face image, which is based on dominant frequency content, has been successfully implemented for face recognition. By using the global/holistic features concept as dimensional reduction of the face image can compress about 99.39% of the original size (i.e., less than 100 elements of 16384 elements) which gave good enough performance. It means the frequency analysis based global features is an efficient way for reducing the original data dimensional. Therefore, that holistic features concept, which is combined with the Alternative PCA (APCA), predictive LDA (PDLDA), and integration of them, is implemented to create real-time face recognition. This proposed method is an alternative approach to face recognition algorithm that is based on global/holistic features of face image, which is combined with APCA and PDLDA to overcome large computational costs and retraining problem of the conventional