氏名(国籍･生年月日)　Chua Min Zhi（マレーシア　1981年2月21日）
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学位論文題目　A Study on Exact and Abstract Measurement Face Classification Using Linear-based Algorithms
（ 線形アルゴリズムを用いた厳密および抽象尺度に基づく顔画像分類の研究 ）
論文審査委員　主査　教　授 田中 清　　准教授 アギレ エルナン
教　授 杉村 立夫　助教　白井 啓一朗
准教授 児玉 明（広島大学）

論 文 内 容 の 要 旨

Face classification is one of the subbranches of the image classification in computer vision. It includes a wide range of decision-theoretic approaches of machine learning to categorize face images into some predefined classes by analyzing the numerical properties of various face features. Depending on the predefined classes for the faces to be classified into, face classification can be categorized into 2 categories: (i) exact measurement face classification, and (ii) abstract measurement face classification. The exact measurement face classification has a crisp and clear definition of face classes, such as gender and identity, whereas the abstract measurement face classification has a vague definition of face classes, such as attractiveness. Among the different face classification approaches, linear-based approaches are known for their high accuracy performance, short processing time, and simplistic nature. This study proposes linear-based approaches in both exact measurement and abstract measurement face classification that can achieve high accuracy, able to tolerate face images in some reasonable variations in poses, lightings and face expression without compromising the speed of the algorithms.

Chapter 2 first presents an overview of the linear-based algorithms. Then, it describes Principal Component Analysis (PCA), Linear Discriminant Analysis (LDA) and Fisher Linear Discriminant Analysis (FLD) in detail.

For the exact measurement face classification, this work deals with the face recognition, where the face classes are either known faces (users) and unknown faces (intruders) for face authentication or users' identities for face identification. **Chapter 3** addresses the issues of the conventional FLD method and proposes a

hybrid FLD methodology. The hybrid methodology combines the benefits of both global approaches that exploit whole face region for face features and local approaches that utilize local features, such as eyes, nose and mouth. In the proposed methodology, face images are divided into five components i.e., Fisher-face, Fisher-eyes, Fisher-eyesnose, Fisher-nosemouth and Fisher-mouth, to overcome the limitation of the conventional method in handling face images of an intruder. Results suggest that the proposed methodology is able to achieve 99*:*2% and 98*:*6% of accuracy in face authentication for the AT&T and MZ datasets, respectively. This methodology also yielded 97*:*5% and 96*:*3% of accuracy for face identification in the AT&T and MZ databases, respectively. The results of the proposed methodology are better than other conventional methods and other hybrid methods for both face authentication and face identification.

For the abstract measurement face classification, this work deals with the face classification based on personal attractive preference, where faces are categorizes into attractive, common and non attractive classes depending on how appealing the faces are, for each participant. **Chapter 4** addresses the issues of the conventional PCA-based approaches for face classification based on attractiveness, and proposes a new methodology that uses class-specific eigenfaces and image reconstruction method to classify both Asian female and male faces based on personal attractive preference. The proposed methodology handles each class separately to obtain eigenfaces, which differs from the conventional PCA-based methods that trained face images in all the classes as one huge training set. Thus, the new methodology is able to produce eigenfaces that contain more specific face information for each class when compared to those produced by the conventional methods. Then, classification is performed by measuring the similarity between the test image and the reconstructed images using the class-specific eigenfaces. From the experiments, while the accuracy results vary depending on the participants' personal attractive preference, the proposed method outperforms conventional methods for all the participants, with a confidence level of 95% according to the Wilcoxon signed-rank test. In the 3-class classification, the proposed method achieves improvement in average accuracy ranges from 7.7% to 15.1% and 2.9% to 17.4% for the female and male datasets, respectively. Also, in the case of the 2-class classification, the improvement in average accuracy ranges from 6.3% to 17.7% and 5.2% to 16.6% for the female and male datasets, respectively. The proposed methodology not only achieves significant improvement in accuracy, its computational order still remains the same when compared with other conventional methods.

Finally, **Chapter 5** summarizes this research, presents conclusions, and suggests future researches.