論文の内容の要旨

A Linear Algebraic Approach to Intraclass Shape Analysis and Its Application in Archaeological Research

（同一クラス内形状解析への線形代数的アプローチと
その考古学研究における応用）

氏名　呂　　敏

Shape analysis is one of the fundamental problems in computer vision. It includes not only geometry comparison, but sometimes structural and semantic analysis as well. In particular, if objective shapes belong to the same class, the problem is specified to what is named as intraclass analysis. A number of related studies have been published on certain topics, such as 3D face recognition. However, few of them are suitable for the general case.

This thesis focuses on the general problem of intraclass shape analysis. Given a dataset containing samples from the same category, we manage to reveal structural information that is hidden in this group. Furthermore, under the guidance of this information, we successfully solved several related problems, including intraclass shape restoration, clustering and comparison.

In detail, samples are first registered via a non-rigid shape matching process. With the obtained dense correspondences, we then describe input shapes as length-fixed vectors, which constitutes a representation matrix. Considering that these samples are substantially similar in shape, this matrix must be low-rank. Taking this structural information into account, incomplete samples can be simultaneously restored by adopting a matrix recovery scheme. In multiple subcategories case, we improve the accuracy of restoration with cluster analysis. Finally, with the restored data as well as the category information we obtained, identifiable regions are detected on a subset of the dataset that distinguish this subcategory from the others. Notice that all the above processes are fully automatic, without using any prior knowledge about the given shapes as well. Experimental results verify the feasibility and effectiveness of our proposed method.