DOCTORAL THESIS

On study of lip segmentation in color space

Li, Meng

Date of Award:
2014

Abstract

This thesis mainly addresses two issues: 1) to investigate how to perform the lip segmentation without knowing the true number of segments in advance, and 2) to investigate how to select the local optimal observation scale for each structure from the viewpoint of lip segmentation effectively.

Regarding the first issue, two number of predefined segments independent lip segmentation methods are proposed. In the first one, a multi-layer model is built up, in which each layer corresponds to one segment cluster. Subsequently, a Markov random field (MRF) derived from this model is obtained such that the segmentation problem is formulated as a labeling optimization problem under the maximum a posteriori-Markov random field (MAP-MRF) framework. Suppose the pre-assigned number of segments may over-estimate the ground truth, whereby leading to the over-segmentation. An iterative algorithm capable of performing segment clusters and over-segmentation elimination simultaneously is presented. Based upon this algorithm, a lip segmentation scheme is proposed, featuring the robust performance to the estimate of the number of segment clusters. In the second method, a fuzzy clustering objective function which is a variant of the partition entropy (PE) and implemented using Havrda-Charvat's structural α-entropy is presented. This objective function features that the coincident cluster centroids in pattern space can be equivalently substituted by one centroid with the function value unchanged. The minimum of the proposed objective function can be reached provided that: (1) the number of positions occupied by cluster centroids in pattern space is equal to the truth cluster number, and (2) these positions are coincident with the optimal cluster

centroids obtained under PE criterion. In the implementation, the clusters provided that the number of clusters is greater than or equal to the ground truth are randomly initialized. Then, an iterative algorithm is utilized to minimize the proposed objective function. The initial over-partition will be gradually faded out with the redundant centroids superposed over the convergence of the algorithm.

For the second issue, an MRF based method with taking local scale variation into account to deal with the lip segmentation problem is proposed. Supposing each pixel of the target image has an optimal local scale from the segmentation viewpoint, the lip segmentation problem can be treated as a combination of observation scale selection and observed data classification. Accordingly, a multi-scale MRF model is proposed to represent the membership map of each input pixel to a specific segment and local-scale map simultaneously. The optimal scale map and the corresponding segmentation result are obtained by minimizing the objective function via an iterative algorithm.

Finally, based upon the three proposed methods, some lip segmentation experiments are conducted, respectively. The results show the efficacy of the proposed methods in comparison with the existing counterparts.

Acknowledgements

This thesis would not have been possible without the advice and help of several individuals who contributed and extended their valuable assistances in the completion of this study.

First and foremost, I offer my sincerest gratitude to my principal supervisor Prof. Cheung Yiu-ming, for the patient instruction he has provided throughout my study period, and for his continual support on both academic and personal problems. Indeed, his guidance and advice have had a major positive impact on my development as a scientific researcher and as an individual.

I am very grateful to Dr. Zhang Hui, the CEO of Shenzhen CloudRiver Information Technologies Co. Ltd, for the invaluable suggestions, for the stimulating discussions, and for the sleepless nights we were working together. Thanks are also due to my fellow lab mates Dr. Liu Xin and Dr. Jia Hong for their insightful advices about my research work.

I thank my friends in Harbin Institute of Technology: Dr. Li Qiong, Dr. Huang Fu-rong, Dr. Han Qi, Dr. Jiao Yu-hua, Dr. Chen Yang and Dr. Li Jun. In particular, I appreciate Prof. Niu Xia-mu for enlightening me the first glance of research.

I am also deeply indebted to my friends Ms. Chai Yue and Ms. Shi Yan-bing for being the constant source of encouragement. It means a lot to me.

Last but not least, I express my special gratitude to my parents, Li Li-ping and Lv Min, for giving me all the dedication and understanding a child could want. I love you.

Table of Contents