Double Complete D-LBP with Extreme Learning Machine Auto-Encoder and Cascade Forest for Facial Expression Analysis

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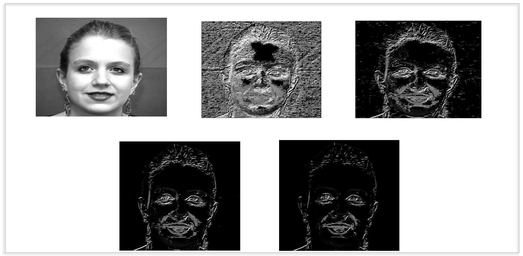
Abstract

Although the obtained accuracy on some lab-controlled facial expression datasets has been very high, the recognition of facial expressions in wild environments is still a challenging problem. Local Binary Patterns (LBP) is a widely used operator in facial expression recognition. However, there are few variations of LBP operators specifically designed for facial expression recognition. In this paper, we propose a novel representation approach called the Double Complete d-LBP (Double Cd-LBP) according to the characteristics of facial expressions. Two d-LBP are employed to represent details and the contour of faces separately, and complete LBP is used to take sign and magnitude components into account. Moreover, multi-scale LBP is exploited to obtain local texture and global information. We then use the extreme learning machine auto-encoder (ELM-AE) as the feature selection approach to learn the discriminative feature. Cascade forest is employed as the final decision classifier. Experiments conducted on the six facial expression databases, including both lab-controlled and wild environments databases, show that our method outperforms or on par with state-of-the-arts.

Background

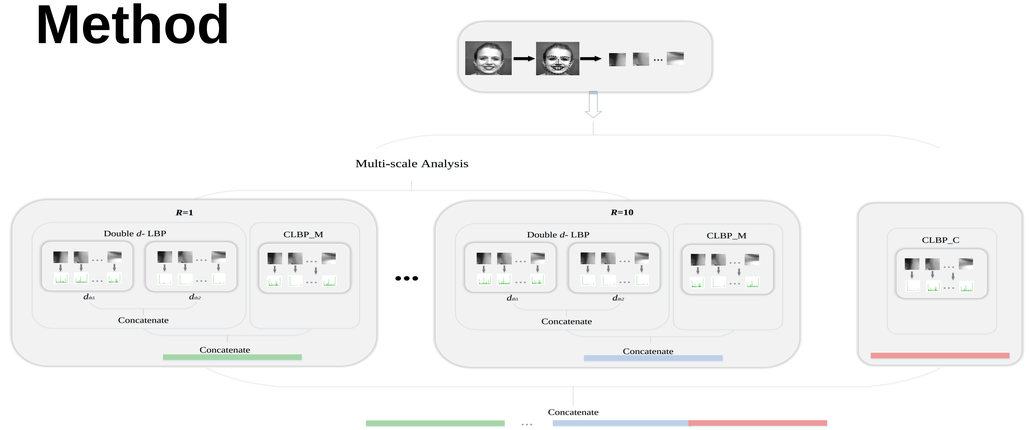
Many algorithms have been proposed for automatic facial expression recognition, in which the most crucial part is feature extraction. In feature extraction, the choice of descriptor and the way to extract features determine the quality of extracted features. In addition to feature extraction, both the method of feature selection and the choice of classifier have a great impact on the final accuracy.



In the past, variations of the original **local binary patterns (LBP)** operators focus on different aspects: improvement of discriminative ability, enhancement of robustness, the choice of neighborhood, extension to 3-D features, and combination with other methods. Therefore, we propose the Double Complete d-LBP (Double Cd-LBP) that is specific to facial expression analysis.

Method

- **Pretreatment**, e.g. face alignment and cropping faces into the same size, patches which have the size of 20×20 are generated centering around the landmarks of an input image. The number of patches equals to the number of landmarks.
- **Calculate the histogram of Double Cd-LBP/M_C in each patch**, which is centered at each landmark. The histograms of each patch are concatenated in series as the representation of the whole image. Two different d is applied at each scale, a smaller d_{th1} for the detail of the facial expression and a larger d_{th2} for the outline. A histogram of the CLBP_M is calculated in each scale and it is then concatenated with features created by two d-LBP operators. Finally, the histogram of CLBP_C is built, and it is concatenated in the final vector.
- **Feature Selection and Classification.** We employ non-linear Sparse ELM-AE (SELM-AE) to select and reduce dimension of the feature and the classifier we choose is the cascading forest of deep forest.



Results

Database	Proposed method	State-of-the-arts
MMI	88.1	86.9, 81.5, 79.8
CK+	97.6	97.9, 93.6, 92.4
JAFFE	95.2	98.6, 95.8, 90.4
SFEW	62.5	62.1, 51.0, 26.1
RAF-DB	78.6	74.2, 68.2
CIFE	81.0	81.5, 74.0

Database	Single d-LBP	Double d-LBP
MMI	81.02	85.64
CK+	90.95	93.18
JAFFE	90.40	94.44
SFEW	29.49	47.36
RAF-DB	42.86	63.65
CIFE	57.14	64.04

Conclusions

- ✓ A Double Cd-LBP based facial expression recognition method is proposed in this paper.
- ✓ The key advantages of Double Cd-LBP method is that it takes both details and the contour, the local and global information of faces and different component of LBP operator into account, which can fully extract the information of facial expressions.
- ✓ Experiments are conducted on six databases including both lab-controlled and wild environments databases to illustrate the effectiveness of the proposed method in comparison with state-of-the-arts approaches.
- ✓ Double Cd-LBP achieves better performance in one lab-controlled dataset (MMI) and two wild datasets (SFEW and RAF-DB) compared with state-of-the-arts methods in terms of mean accuracy.

References

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