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Kinship verification using neighborhood repulsed correlation metric learning☆

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ABSTRACT

Kinship verification is an interesting and challenging problem in human face analysis, which has received increasing interests in computer vision and biometrics in recent years. This paper presents a neighborhood repulsed correlation metric learning (NRCML) method for kinship verification via facial image analysis. Most existing metric learning based kinship verification methods are developed with the Euclidian similarity metric, which is not powerful enough to measure the similarity of face samples, especially when they are captured in wild conditions. Motivated by the fact that the correlation similarity metric can better handle face variations than the Euclidian similarity metric, we propose a NRCML method by using the correlation similarity measure where the kin relation of facial images can be better highlighted. Since negative kinship samples are usually less than positive samples, we automatically identify the most discriminative negative samples in the training set to learn the distance metric so that the most discriminative encoded by negative samples can better exploited. Experimental results show the efficacy of the proposed approach.

1. Introduction

People can infer many important characteristics from human facial images, and representative examples are face recognition [1–9], facial expression recognition [10–12], facial age estimation [13–18], gender classification [19] and ethnicity recognition [20,21]. Motivated by some observations in psychology and cognitive sciences [22], researchers in computer vision have proposed several computational approaches [23–38] to kinship verification via facial image analysis in recent years from two aspects: feature-based [23,25,28,29,39-41] and model-based [26,33-35]. Typical feature-based kinship feature representation methods include skin color [23], histogram of gradient [23,25,30], Gabor wavelet [26,29,30,42], gradient orientation pyramid [29], local binary pattern [33,43], scale-invariant feature transform [30,33,35], salient part [27,28], self-similarity [44], and dynamic features [39]. Representative model-based kinship verification methods are subspace learning [26], metric learning [33,35,45], transfer learning [26], multiple kernel learning [29], and multiple feature fusion [34].

Recent advances in kinship verification have shown that metric learning is an effective technique for kinship verification and several metric learning algorithms have been proposed for kinship verification in recent years. For example, Lu et al. proposed a neighborhood repulsed metric learning (NRML) [33] method by considering the different importance of different negative samples for kinship verification. Yan. et al. presented a discriminative multi-metric learning (DMML) [35] by making use of multiple feature descriptors for kinship verification. While encouraging performance have been obtained, these methods only use the Euclidian similarity distance for metric learning, which is not effective enough to handle illumination of facial samples in verifying the kin relations.

This paper presents a neighborhood repulsed correlation metric learning (NRCML) method and apply it for kinship verification via facial image analysis. Some facial images with kin relations are shown in Fig. 1. Most existing metric learning based kinship verification methods are developed with the Euclidian similarity metric, which is not powerful enough to measure the similarity of face samples, especially when they are captured in wild conditions. Motivated by the fact that the correlation similarity metric can better handle face variations than the Euclidian similarity metric, we propose a NRCML method by using the correlation similarity measure where the kin relation of facial images can be better highlighted. Since negative kinship samples are usually less than positive samples, we automatically identify the most discriminative negative samples in the training set to learn the distance metric so that the most discriminative encoded by negative samples can better exploited. Finally, we show the efficacy of the proposed approach on two widely used facial kinship datasets.

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Fig. 1. Some positive sample pairs from the KinFaceW-I [33] (row 1), KinFaceW-II [33] (row 2), Cornell KinFace [23] (row 3) and UB KinFace [46] (row 4) datasets, respectively.

2. Related work

2.1. Kinship verification

Some kinship verification methods via facial image analysis have been proposed in recent years [23,25,26,28,29,33,39,44,46,47]. Representative methods include skin color [23], histogram of gradient [23,25,30], Gabor wavelet [26,29,30,42], gradient orientation pyramid [29], local binary pattern [33,43], scale-invariant feature transform [30,33,35], salient part [27,28], self-similarity [44], and dynamic features [39], subspace learning [26], metric learning [33,35,45], transfer learning [26], multiple kernel learning [29], and multiple feature fusion [34]. In this work, we propose a model-based kinship verification approach by using metric learning. Unlike most existing metric learning based kinship verification methods which are developed with the Euclidian similarity metric, we propose a neighborhood repulsed correlation metric learning method by using the correlation similarity measure where the kin relation of facial images can be better highlighted. In the learned distance metric space, face variations can be better modeled.

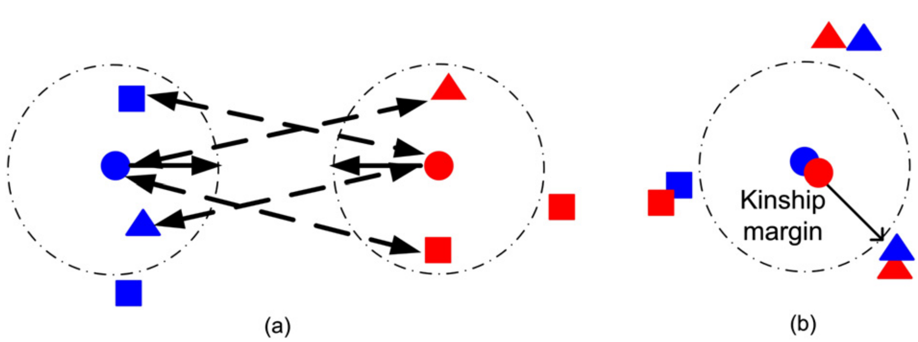

Fig. 2. Key idea of the proposed NRCML method. Since negative kinship samples are usually less than positive samples, we automatically identify the most discriminative negative samples in the training set to learn the distance metric so that the most discriminative encoded by negative samples can better exploited.