H-029

A face tracking method using face direction information

顔向き情報を利用した位置予測による顔追跡

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1. Introduction

Video face tracking is an important issue in computer vision, and is helpful for many practical applications, such as video surveillance. With the improvements in detection and tracking techniques in recent years, tracking performance has been improved remarkably [1]. However, serious conditions, such as occlusion, abrupt moving direction change, etc. are still limiting the performance of tracking. As the other methods [2] use only past location information for prediction, the predicted location tends to deviate under occlusion on face or abrupt moving direction change. In this paper, we solve this problem by using face direction information for face tracking, which uses both current and past face direction information for prediction. The effectiveness of proposed method for improving tracking performance is proven on both indoor and outdoor data set.

2. Face tracking methods

Generally, face tracking methods are composed of three steps: (1) prediction: predicted location of the target face in the current frame is calculated based on face location information in the past frames; (2) association: the predicted face on corresponding trajectory is associated with detected face; (3) updating: the estimated face location is calculated based on both detected face location and predicted location. As a result, the trajectory of the target face is updated.

However, if the detected faces are unavailable due to occlusion or abrupt moving direction change, prediction of face location is carried out based on older locations. This usually leads to deviation in trajectory. We solve this problem by introducing face direction information of the current frame in prediction.

3. Proposed face tracking algorithm using face direction information

The direction information of the target face in both past and current frame is utilized to improve the precision of predicted location. There are two assumptions of the motion model in our proposed algorithm. (1) The moving direction of the target person and corresponding face direction are identical. (2) Motion of target person in real world conforms to circle model. The flowchart of tracking is shown in Fig. 1. Firstly, location, size and direction of all the faces in each frame are detected. The image coordinates of the past estimated face location on the trajectory is transformed into real world. Using direction information of detected faces in the current frame, the predicted face location corresponding to each detected face related to the target trajectory are calculated in the real world. Then predicted locations corresponding to each detected face are projected conversely into image. Finally, data association is carried out and the best face is determined to update target trajectory.

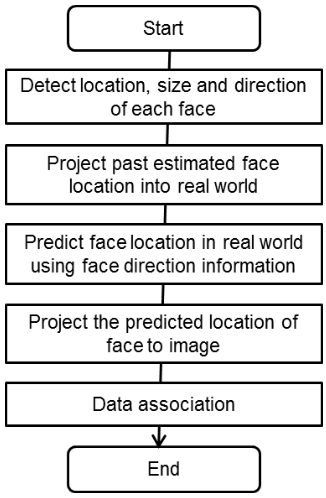

Figure 1. Flowchart of proposed face tracking algorithm.

3.1 Face location prediction using face direction information

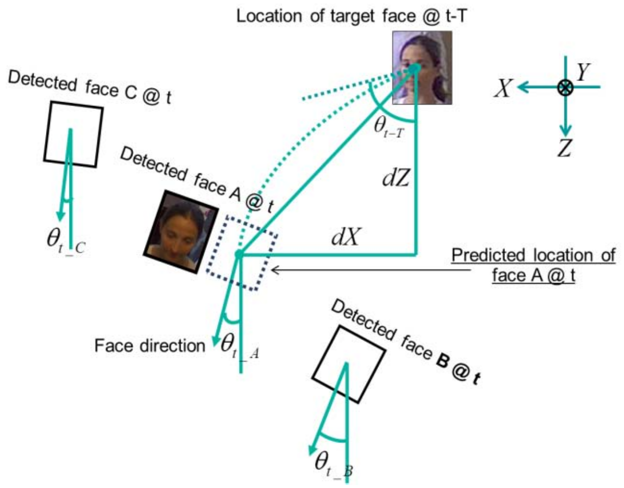

Figure 2. Face location predication and data association.

On the circle model assumption, past and current location of the target face in real world, face direction θ_{t-T}, θ_T, and eye distance w_{t-T} and w_T in image are utilized to predict face

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locations in the current frame. Movement in Z direction is calculated using formula (1). Face direction plays a role in calculation of movement in X direction under formula (2). Predicted locations are fixed based on dZ and dX .

$$dZ = (\frac{w_{t-T}}{w_T} - 1) Z_{t-T} \qquad (1)$$

$$dX = \frac{dZ}{\tan(\frac{\pi - |\theta_t - \theta_{t-T}|}{2} - |\theta_t|)} \qquad (2)$$

3.2 Date association

For each trajectory, predicted locations in the current frame are calculated for all the detected face locations (detected face A, B, C in Fig. 2). The pair of detected face location and the corresponding prediction location with the least distance is selected as the best matching to update the trajectory.

3.3 Combination with tracking method without using face direction information

There are situations, for example, the talking scenes including people facing other people on their way, which the assumption (1) is not met. To deal with this issue, we predict the face location of each target trajectory by both proposed method and tracking method without using face direction information in parallel. And the predicted face location, which is closer to the corresponding detected face, is chosen in data association step to update the target trajectory.

4. Experiments

We evaluated our proposed method on both indoor and outdoor data sets. The indoor chokepoint data set [3] including 25 persons is used for evaluation of performance against occlusion (Fig. 3). The outdoor data set is used to evaluate the robustness against abrupt moving direction change.

4.1 Evaluation metric

In order to evaluate tracking performance, we adopt the evaluation metric defined as ID switch ratio, which indicates whether the target face is tracked correctly so that the trajectory represents single ID of target person through the whole scene. For this metric, lower scores indicate better performance.

ID switch ratio =
(<The number of total trajectory> - <The number of correctly tracked trajectory>) / < The number of total trajectory >

4.2 Indoor experiment

As shown in Fig. 3, the face of a woman is occluded during a period of this scene. Since the predicted location of the face deviated during occlusion, tracking without using face direction information failed. Meanwhile, tracking under our proposed method continues successfully. As a result the woman is recognized correctly as the same people during the whole scene.

4.3 Outdoor experiment

The outdoor data set includes 20 scenes of 10 persons moving in curve. In these scenes, the target persons walk and change their walking direction fast in the middle of the scene.

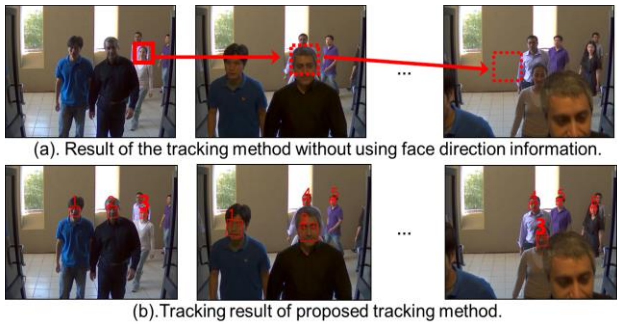

Figure 3. Evaluation results for “chokepoint” outdoor scene with occlusion, including 25 persons moving in curve.

Table 1. ID switch rate of outdoor scenes (%).

Tracking method without using face direction information	Proposed method
0.31	0.091

Table 1 shows the ID switch ratio of outdoor scenes. For the scenes of persons moving in curve, ID switch ratio of proposed tracking method is decreased into 9.1%, one third of the ratio 31% of the tracking method without using face direction information. These results have proven the improvement of tracking performance by adopting face direction information for face location prediction.

5. Conclusion and future work

We described a face tracking method using face direction information for predicting location of the target face. Our proposed prediction method leads to the improvement of tracking performance, especially for scenes with occlusion on face and abrupt moving direction change. In order to further confirm the effectiveness of the proposed method on general environment, experiments on larger data set with more variations of motion pattern, number of person, etc. will be carried out.

Reference

[1] Chellappa, Rama, et al. "Face tracking and recognition in video." Handbook of Face Recognition. Springer London, 2011. 323-351.

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[3]. Y. Wong, S. Chen, S. Mau, C. Sanderson, B.C. Lovell Patch-based Probabilistic Image Quality Assessment for Face Selection and Improved Video-based Face Recognition IEEE Biometrics Workshop, Computer Vision and Pattern Recognition (CVPR) Workshops, pages 81-88. IEEE, June 2011.

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