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A New Multi-Stage Face Identification in Motion Picture

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ABSTRACT

This paper describes a new face identification algorithm with two stages. This first stage monitors a sequence of face images to select a desired frame for identification and face identification is performed in the second stage. The face identification algorithm is based on the geometric parameters of size and distance of the facial feature objects (the eyes, the nose, the mouth, etc.)

The frame selection of the front-view face from a sequence of motion images is effectively executed by a simple calculation. Experimental results have verified that this face identification algorithm can improve the man-machine interface to become friendly in a security system.

1 Introduction

Many studies on face identification have been reported [1]. Recently several new studies have been done, which identify persons with a frame of the front-view face; for example, an algorithm based on KL expansion [2], and with neural network [3]. Most of conventional studies have focused on the face identification algorithm itself. There have been few studies which mentioned how to obtain a desired frame for identification.

Identification performance, however, is degraded when the human posture changes. In order to reduce the influence of posture variation, some algorithms have been proposed; for example, an algorithm preparing several templates for identification [4]. For practical use, a desired frame should be selected automatically in the identification system.

With aids of newly developed image processing hardware and software, motion image analysis can be realized in face identification. Especially in a computer-user security system, it is required to perform face identification intermittently during their operation as well as without any interruption of their operation. It is expected that the system can identify them with their natural behaviors.

The problem to be solved is to develop an algorithm which automatically selects a desired frame from motion images to extract required feature parameters.

My approach is to prepare a new judgement stage where a desired frame of the front-view face is effectively selected from a sequence of motion images and an identification stage.

In Section 2, a new approach to solve the current problem is proposed. In Section 3, detail algorithm is described, and experimental results are shown in Section 4.

2 Two-stage Identification Algorithm

While conventional algorithms weight how to extract desired features from an image, the proposed algorithm weights how to automatically select a desired frame from motion images for identification. Fig. 1 shows a block diagram of the proposed algorithm. This two-stage identification algorithm consists of a valid frame judgement stage and an identification stage.

In the first stage, the valid frame judgement is per-

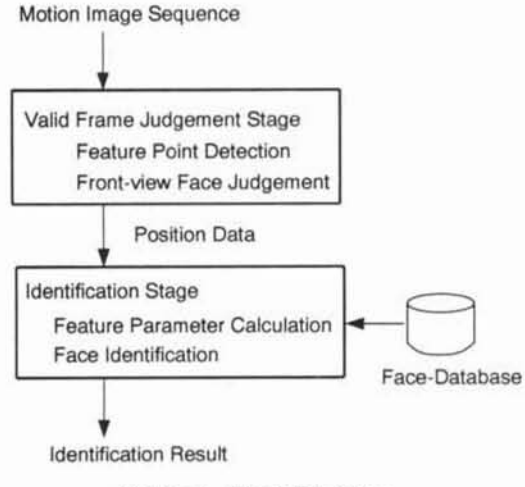

Figure 1. Block Diagram

formed to select a desired frame from a sequence of motion images. Facial feature points are detected in a whole face region, and then position data of facial feature points are examined whether a given frame is the front-view face , or not. If the judgement result is valid, the position data is sent to the next stage to identify the person. If invalid, the valid frame judgement is repeatedly executed with the next frame.

In the second stage, facial feature parameters are calculated with these position data, by which face identification is performed.

3 Detail Algorithm

3.1 Valid Frame Judgment Stage

Fig. 2 shows 15 facial feature points which can be stably extracted by a computer. The ear feature points and the chin feature points are not used here because ears are sometimes covered with hair and the chin edge disappears in its image data.

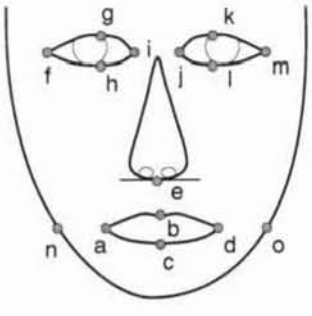

Figure 2. Facial Feature Points

To get better detection accuracy of these points, 11 search regions shown in Fig. 3 are sequentially determined. The region number in Fig. 3 indicates the searching order of each facial feature points.

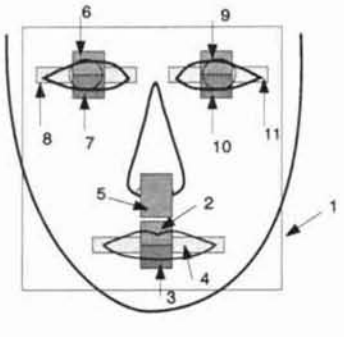

Figure 3. Search Regions

At first, the whole face region (1) is obtained in an input frame by finding the pre-defined color region. The mouth regions (2, 3 and 4) are determined by the whole face region data, where four mouth feature points (a, b, c and d) are searched by edge operators. Then, the nose region (5) is obtained by this mouth region data, and so on. Cheek points (n and o) are extracted by searching along the boundary of the whole face region and the background region.

The front-view face judgement is performed by calculating the amount of head rotation for two axes as shown in Fig. 4 (A and B axes). The calculation of the head rotation for C axis is not implemented in this algorithm because it is difficult to measure the rotation amount.

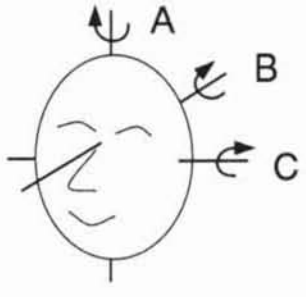

Figure 4. Rotation Axes

The amounts of head rotation for A axis and B axis are computed by the absolute difference ΔCheek of the two distances (D1) and (D2), and the absolute difference (ΔEye in Fig. 5) between center positions of both eyes, respectively as shown in Fig. 5. If the each difference is less than its pre-determined threshold, the input frame is judged as the front-view face.

If the desired frame is selected, position data of 15 facial feature points are sent to the identification stage. And

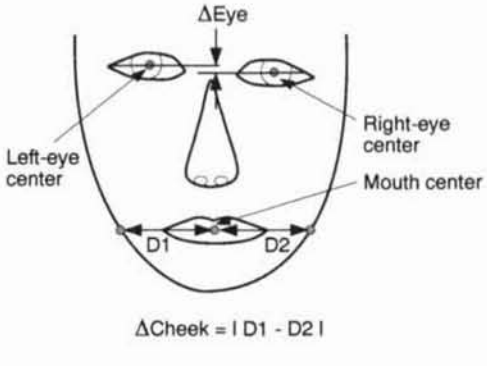

Figure 5. Parameters for Rotation Measurement

if not, valid frame judgement is repeatedly done for the next frame.

3.2 Identification Stage

Fig. 6 shows 10 feature parameters which are calculated with position data of 15 facial feature points; widths, and heights of the left-eye, right-eye, and mouth as well as distances between both eyes, forehead to nose, nose to the center of the mouth, and both cheek edges.

These parameters are examined whether they are appropriate or not for identification by comparing them with minimum and maximum thresholds. And then, identification is performed by the conventional minimum-distance classification method.

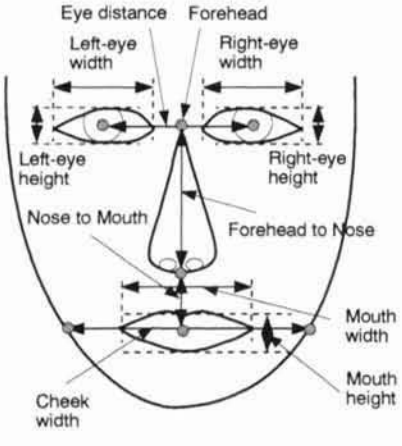

Figure 6. Facial Feature Parameters

4 Experimental Results

Two experiments were done on assumption that users were sitting in front of a computer and naturally operating it. A set of 40-user images with the front-view face were taken for identification. Several sequences of motion images (male/female, with/without glasses, etc.) were taken for the valid frame judgement.

Using the latter motion images, the first experiment was performed to select a desired frame. As shown in Fig. 7 and 8, the algorithm correctly extracted the just frame of the front-view face. While Figs. 7.1 to 7.3 show a series of frames, Fig. 7.2 was correctly selected as the frame of the front-view face and the person was properly identified. Figs. 7.1 and 7.3 were rejected because of the head rotation for the A axis. Fig. 7.4 shows the correct resultant frame, which corresponds to Fig. 7.2 with some feature regions and points. As demonstrated in Fig. 8, the valid frame judgement was rightly done with the head rotation for the B axis.

The second experiment about face identification was performed on a set of 50-user images. Their front-view faces were manually selected, where 40 users were used to generate an identification dictionary. At present, about 90% of identification accuracy is obtained.

Figure 7.1

Figure 7.2

Figure 7.3

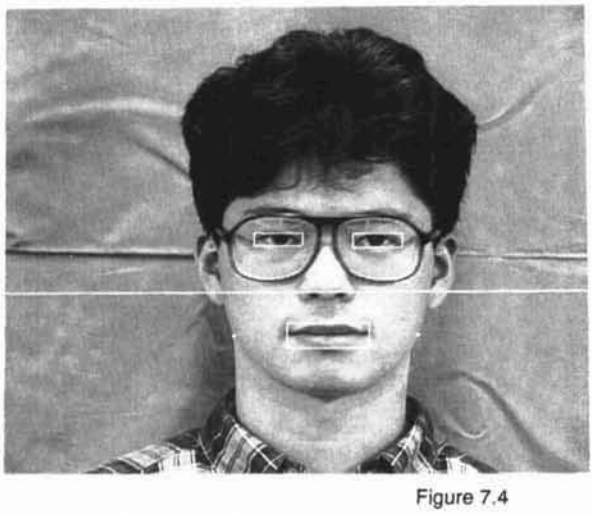

Figure 7.4

Figure 7. Experimental Result-1

Figure 8.1

Figure 8.3

Figure 8.3

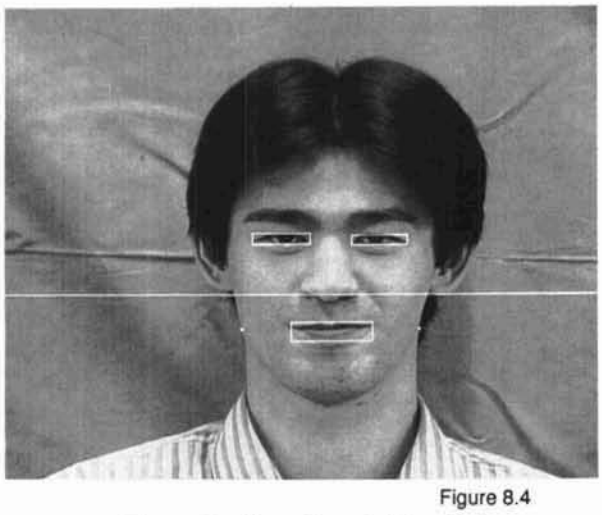

Figure 8.4

Figure 8. Experimental Result-2

5 Conclusion

A new face identification algorithm with two stages has been proposed, which can detect the frame of the front-view face from a motion image sequence and identify persons so effectively. This algorithm is useful in improving the man-machine interface of a security system in a practical sense. Experimental results have demonstrated that the frame of the front-view face was correctly detected from a motion image sequence and identified. This indicates that my algorithm is efficient enough to explore practical applications in man-machine interfaces.

A further improvement of the algorithm for a large number of human identification, which is currently being developed, is to make use of facial object figure information for identification parameters and reduce the influence of expression on the face.

Acknowledgments

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