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Study on an Improved Restricting Algorithm Used in Face Image

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Abstract

The recognition rate of face image has always been a research hot spot. This paper proposes a model based on tree sparse algorithm. Firstly, create a kind of tree sparse model of image data based on the wavelet domain, and then design a new face image reconstruction algorithm with this model. The algorithm in this paper is used to eliminate the redundant information of the face image, by comparing with the traditional reconstruction algorithm and testing with three standard faces data, comparing with the reference algorithm, the simulation experiments show that the algorithm of this paper improves the recognition precision of human face image, with very good robustness.

Keywords*: tree sparse model, reconstruction algorithm, human face image recognition*

1. Introduction

Face recognition technology is a research hotspot in the field of image processing and pattern recognition in recent years [1].At present, face recognition algorithm is mainly based on global feature extraction algorithm and local feature extraction algorithm, and because the local feature extraction algorithm has very good stability factor and recognition rate, it is one of the main methods in face recognition in recent years [2]. Literature [3] proposes a method combining local phase quantitative characteristics basis with multi-scale classification. And classifying and identifying according to the principle of multi-scale rule, the simulation experiments show that this method has higher recognition rate. Aiming at the disadvantages that equidistance mapping (Isomap) algorithm has unstable topological structure in processing a disturbing image, literature [4] proposes an improved algorithm, which can effectively solve the unstable image phenomenon. Literature [5] puts forward the factor analysis for the face, and then facial gesture factors are isolated, using the sparse representation for human face classification. The experimental results show that the method has good robustness in blocking face and attitude change. Literature [6] proposes fast orthogonal matching pursuit (FOMP) algorithm, and the simulation results show that these methods can improve the noise face recognition rate, having a certain practical value. Literature [7] puts forward to reconstruct image with related eigenvalue method in face image, and the simulation experiments show that this method has a certain effect. Literature [8] proposes a method based on the complete local binary pattern (CLBP) for face recognition, and the simulation experiments show that the results from this method have higher robustness. Literature [9] proposes a face sub image recognition method based on features sampling and fusion. The global feature information and the information after sampling are integrated. Literature [10] proposes a face recognition method based on Gabor wavelets and Memetic algorithm, and the experimental results show that the algorithm can achieve higher recognition rate than the existing face recognition methods.

To solve above problems, this paper proposes a human face image data reconstruction algorithm based on sparse tree model. First of all, establish a sparse tree model of face image data. Compared with the traditional perception reconstruction algorithm,

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experimental results show that, this paper can effectively decrease image reconstruction data amount in data transmission that has the very good application value.

2. Problem Description

At present, in cloud computing, it has become the research hotspot how can transmit multimedia data fast and accurately, and data transmission becomes a part of the multimedia image transmission. This paper elaborates the effective face image in the process of transmission, using $x_n (n \in \{1, 2 \ldots N\})$ to represent No. n face image data. In order to ensure the effective volume of data measurements, the node creates a measurement matrix Ψ_j of the pseudo-random sequence structure after facial image test data to measure the collected data of nodes

$$y_j = \Psi_j x_j \tag{1}$$

In the formula, $x_j \in R^n$, $y_j \in R^m$, $\Psi_j \in R^{m \times n}$.The measured value vector of the M dimension, the original image as $x = \left[x_1, x_2 \ldots x_j \right]^T$, the relationship between them is shown as follows:

$$y = \Psi x \tag{2}$$

Resume $M \times N$ dimension measurement matrix is used to represent the relationship

$$\Psi = \begin{pmatrix} \Psi_{11} & \cdots & 0 \\ \vdots & \ddots & \vdots \\ 0 & \cdots & \Psi_{ij} \end{pmatrix}_{M*N} \tag{3}$$

In formula (1), the reconstructed data is the typical sparse problem. This equation in a non-equilibrium state, thus causing equations having a number of solutions, in the aggregate, the solution of the system of linear equations can be transformed to the minimization problem:

$$\arg\min \|x\|_1 \quad \text{s.t.} \quad y = \Psi x \tag{4}$$

3. Data Reconstruction

3.1. Sparse Model

This paper adopts the tree sparsity based on the wavelet decomposition. The length of signal x is $L = 2^N$. The wavelet domain sparsity of signal η sparse can be written as:

$$\eta = \sum_{i=0}^{i-1} \sum_{j=0}^{2^i - 1} x_{i,j} \psi_{i,j} \tag{5}$$

Take wavelet function $\psi_{i,j}$ as the matrix column to get wavelet transformation matrix Ψ, the wavelet domain sparsity expressed in formula (5) can be written with the following matrix vector:

$$x = \Psi \alpha \tag{6}$$

α as the sparse coefficient, and formula (7)can be expressed as follows

$$\alpha = \left[w_{00}, w_{01,} w_{02} \ldots w_{0j} \cdots w_{i0}, w_{i1} \ldots w_{ij} \right]^T \tag{7}$$

3.2. Algorithm Description

Input: perception measurement matrix, measured value vector y

Output: Reconstruct image data $\hat{x}$

The steps as following:

$\hat{x}_0 = 0$, $d = y$, $i = 0$

Step 1: $i \leftarrow i + 1$

Step 2: Calculate the image conversion value $e \leftarrow \Phi^T d$ (Φ^T is the transposition of matrix Φ)

Step 3: Determine the reconstruction vector factor: $\Psi \leftarrow \min(|e|)$ (the element position with the minimum amplitude in e)

Step 4: $\hat{x}_i \leftarrow M(b)$

$$F_l = \min\left(\left|\left(\Psi_T^{\mathbf{T}} \Psi_T\right)^{-\mathbf{1}} \cdot e\right|\right)$$

Step 6: $d \leftarrow \Phi \hat{x}_i$

Final solution: $\hat{x}_i$ is the final solution

4. Algorithm Simulation

4.1 Comparison of Some Refactoring Algorithms

In order to further verify whether this algorithm has reconstruction for image, we chose the Lena image with 256×256 resolution as to reconstruct image, keeping measurement amount as 50% of the actual data amount. Take the peak signal-to-noise ratio (PSNR) after the image restoration as the judgment standard to measure the reconstructed image. To compare the algorithm in this paper with traditional compression perception reconstruction algorithm,

(a) Original Image

(b) Algorithm Reconstruction Result in Literature [14]

(c) Algorithm Reconstruction Result in Literature [15] (d) Algorithm Reconstruction Result in this Paper

Figure 1. Comparison between the Reconstruction Image and the Original Image

Figure 1 illustrates the comparison of the reconstruction image and the original image in the same reconstructed objects with different reconstruction algorithms. From the contrastive results of the reconstructed images, we can see that the algorithm in this paper can get higher image quality to some extent. Through the evidence of simulation experiment in Figure 2, for the static image with the same resolution, this algorithm computation time is superior to the classic reconstruction algorithm. Put the experimental simulation on the unified platform, for each kind of reconstruction algorithm involved in this paper, the time complexity and space complexity in the spent time and the running process have a certain proportional relations, therefore, the simulation experiment can prove that the reconstruction algorithm of this paper, to a certain algorithm complexity, is much lower than the algorithm of reference [14] and [15].

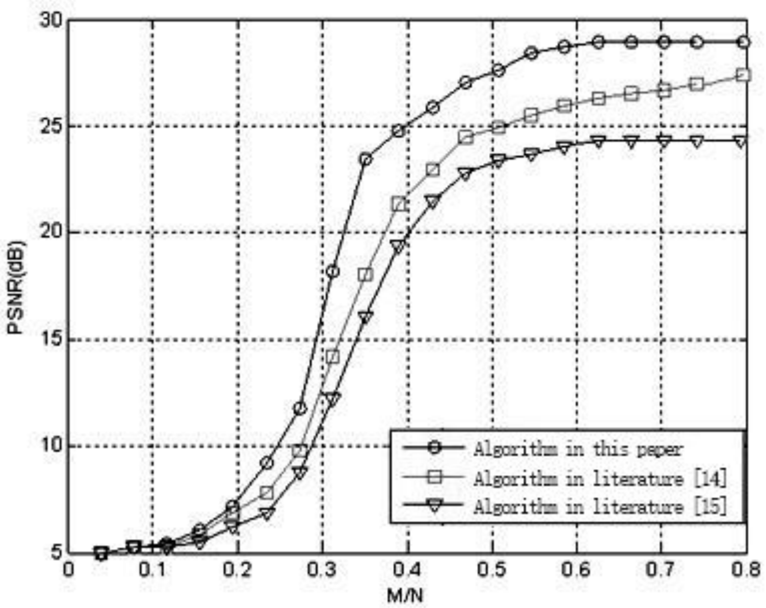

Figure 2. Success Rate of Image Reconstruction

4.2. Face Image Simulation

In order to further improve the face image recognition accuracy, through standard three Yale, ORL, FERET3 face library data sets for simulation experiment, select the typical algorithm in literature [3] and literature [5] to compare with the algorithm in this paper.

(1) Yale face database

There are totally 15 persons in Yale face database. And each person has 11 images. We select 15 images from it, shown as Figure3.

Figure 3. Some Yale Face Sample Images

In selecting each face image in the database, we need to do 30 times experiments, by selecting the average value of data results to compare. The recognition effect of the algorithm in this paper and other two kinds of algorithms is shown in Table 1, and the recognition rate is as shown in Figure 4. From Table 1 and Figure 4 in this paper, the algorithm is superior to the algorithm in literature [5] and literature [6], but the average recognition time is similar. Figure 5 describes the image recognition effect of three algorithms for human face sample under different values.

Table 1. Comparison of Different Features Extraction Algorithms in Yale Database

Features extraction algorithm	The best feature dimension	Face recognition rate（%）	recognition time of each test sample（ms）
Algorithm in literature [5]	48	82.63	14.0
Algorithm in literature [6]	54	65.73	20.3
Algorithm in this paper	87	95.82	29.9

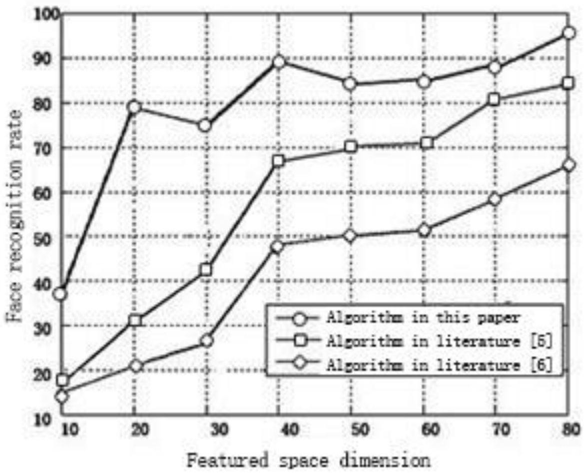

Figure 4. The Relationship Between the Recognition Rate and Feature Dimension in Yale

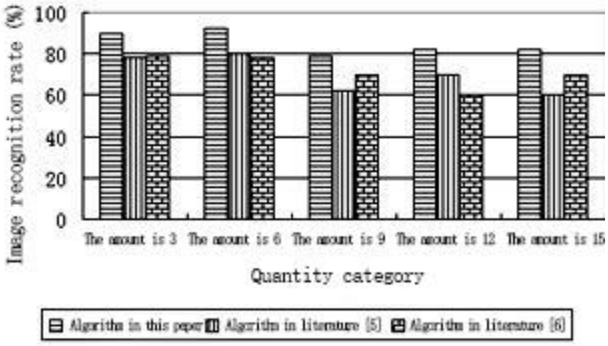

Figure 5. The Recognition of Three Algorithms in Yale Database

(2) ORL face database

There are totally 40 persons in ORL image database. And each person has 1 image. We select 15 ORL images, shown as Figure6.

Figure 6. Some Face Sample Images in ORL

In selecting each face image in the database, we need to do 30 times experiments, by selecting the average value of data results to compare. The recognition effect of the algorithm in this paper and other two kinds of algorithms is shown in Table 2, and the recognition rate is as shown in Figure 7. From Table 2 and Figure 7 in this paper, comparing with the algorithm in literature [5] and literature [6], these three algorithms are similar, but the difference among the best feature dimensions is great. Figure 8 describes the image recognition effect of three algorithms for human face sample under different values.

Table 2. Comparison of Different Feature Extraction Algorithm Recognition Rate in ORL Database

Features extraction algorithm	The best feature dimension	Face recognition rate (%)	recognition time of each test sample (ms)
Algorithm in literature [5]	54	80.74	19.0
Algorithm in literature [6]	72	61.23	25.3
Algorithm in this paper	90	89.97	35.9

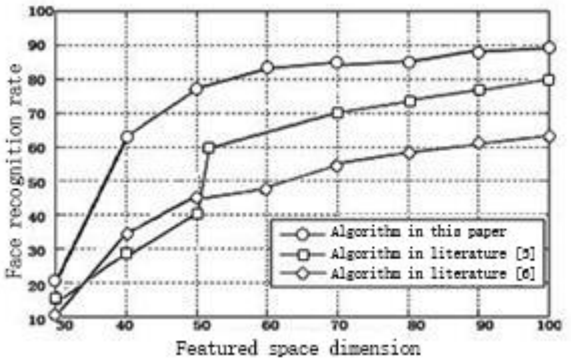

Figure 7. The Relationship between the Recognition and Feature Dimensions in ORL

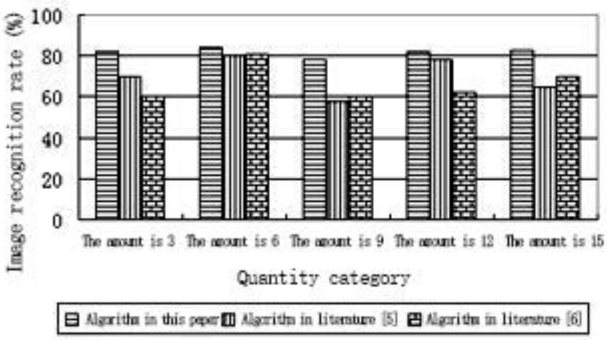

Figure 8. The Recognition of Three Algorithms in ORL Database

(3) FERET face database

Select 15 persons from FERET face database. And each person has 1 image. We select 15 ORL images, shown as Figure9.

Figure 9. Some Face Image Sample in FERET

In selecting each face image in the database, we need to do 30 times experiments, by selecting the average value of data results to compare. The recognition effect of the algorithm in this paper and other two kinds of algorithms is shown in Table 3, and the recognition rate is as shown in Figure 10. From Table 3 and Figure 10 in this paper, comparing with the algorithm in literature [5] and literature [6], the face recognition rate is increased greatly. Figure 11 describes the image recognition effect of three algorithms for human face sample under different values.

Table 2. Comparison of Different Feature Extraction Algorithm Recognition Rate in FERET Database

Features extraction algorithm	The best feature dimension	Face recognition rate (%)	recognition time of each test sample (ms)
Algorithm in literature [5]	62	79.13	36.0
Algorithm in literature [6]	70	62.24	56.6
Algorithm in this paper	110	88.46	87.3

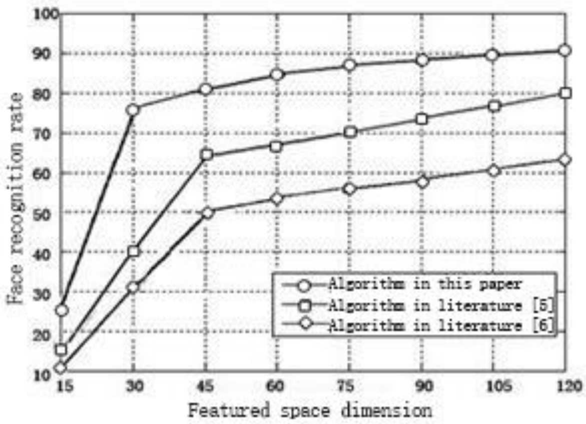

Figure 10. The Relationship between the Recognition and Feature Dimensions in FERET

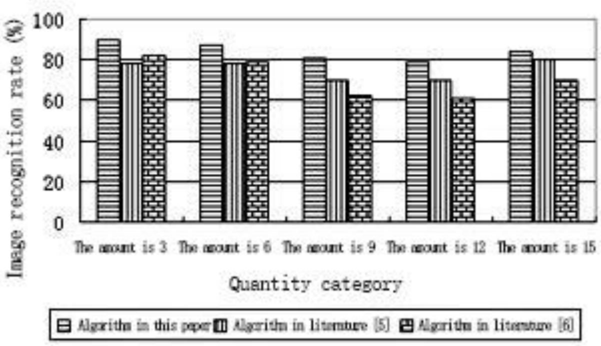

Figure 11. The Recognition of Three Algorithms in FERET Database

5. Conclusion

Face image is always a classic recognition problem, but because of its high redundancy, higher noise, this paper introduces the reconstruction algorithm on the basis of local features in face, through constructing tree sparse model for reconstruction algorithm, making the refactored algorithm can effectively eliminate the redundant information of the human face. Based on the contrast of three classical face databases, the simulation experiment proves that this algorithm can improve the face recognition rate and provide a certain reference for further face image compression transmission.

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