Journal of mathematics and computer science 15 (2015), 32-39

Contents list available at JMCS

Journal of Mathematics and Computer Science

Journal Homepage: www.tjmcs.com

Designing a New Face Recognition System Robust to Various Poses

Behzad Ghanavati

Department of Electrical and Computer Engineering , Mahshahr Branch, Islamic Azad University, Mahshahr, Iran.

Article history:
Received December 2014
Accepted January 2015
Available online January 2015

Abstract

Different scholars in the world design wide varieties of systems for automatic face recognition process. The face recognition process is dependent on different variables, such as the illumination and the different poses of the image. Therefore, face recognition process is still a fundamental issue in image processing. In this paper, we have developed a new method for face recognition based on ant colony algorithm. To assess the performance and effectiveness of the designed system, face images available in ORL database are used. The results obtained indicate that the proposed method for face recognition accuracy is about 97.3 percent. Besides, comparisons indicate that the performance of the proposed method compared to other methods enjoys a remarkable accuracy.

Keywords: Face detection, Face Recognition, Face poses Ant Colony Optimization Algorithm.

1. Introduction

Complexity of automatic identification of human faces is because this system must manage different situations for doing its duty. Some of these conditions include the presence or absence of various emotional expressions in faces, and the presence or absence of structural components of the image (such as makeup, hair, beard, mustache, etc.) the age of subjects in the image (face geometric shape and face recognition approaches are different at different ages), race of people in photo (usually automated methods for face recognition of different people use identical models that this model does not act with similar accuracy for different races), image illuminating conditions (lack of proper distribution of light in the image will lead to lack of edges detection and separation of the components of the face in the background of the image)and pose of face (Usually automatic face detection methods use a set of features extracted from the image for face recognition and these features are collected from clear and fixed shots. In addition, if the pose of face changes, these features will be subject to change. and the face recognition system will experience some difficulties). In relation to each of the factors affecting the performance of face recognition system, a detailed investigation is conducted, e.g., in conjunction with the different poses of face in the picture. By doing this conversion various features of the image in different poses can be synthesized [heo]POSE is still considered as one of the biggest and most important challenges in face detection. It has been found that when the facial features vary significantly from one front shape. Most face detection systems face with difficulties to carry out the diagnosis. In efforts to overcome this, various methods for face detection are performed not based on poses [1, 2, 3, 5, 4, 6]. These methods are commonly used to manage various poses. They must first convert the face to three-dimensional cases and then identify the different poses. The process of converting two-dimensional images into three-dimensional images is a complex and time consuming process. In this paper, a new method for face recognition, independent of the lighting of face and poses, has been submitted. In the proposed method, first the color space of the input image is converted from RGB to HIS. Then using an ant classifier, image pixels are classified into two categories: facial skin and non-skin pixels and face area is determined consequently by following this process. The fuzzy inference system flexibility makes it possible to manage different illumination in the input image. The rest of this paper is thus organized and is described in colony algorithm in section II. In section III, the color space conversion will be explained; in Section IV, the proposed system will be explained; and finally in Section V, experimental results and the performance of the proposed system will be analyzed.

2. Ant colony algorithm

Models based on natural systems are successful samples of solving combined optimization problems (e.g. NP-Hard). The ant colony algorithm is one of these problems, which by presenting a model-oriented search method, has introduced new context in problem solving methods [2].

This model was first introduced by Dorigo, and was used to solve the travelling salesman problem[14]. The ACS algorithm showed desirable efficiency in solving the travelling salesman problem. The structure of the travelling salesman problem assumes a salesman that needs to travel to multiple cities in order to sell his products. Each city is connected to other cities via a road. In order to minimize travel time, the shortest route must be selected in a way that starts from the salesman's city, and passes each city only once, and in the end, returns to the salesman's city. Determining the shortest route for this problem is called the travelling salesman. If the problem space is embodied as a graph, we can say that the travelling salesman problem will result in a minimum Hamiltonian circuit. The ACS algorithm when solving this problem is as follows: assume n cities exist in the problem, which for each two cities of i and j, $d(i,j)$ represents the distance between the two cities. At the beginning of the cycle, the ants are randomly distributed in the cities in *(m<=n)m* numbers. Each ant, moves based on equation (1) after selecting the next city. [7]

In nature, ants find the shortest distance from their hole to their food. Ants use a substance called Pheromone in order to represent their paths. The ant colony optimization algorithm presents a random search method. This method, with the aid of pheromone representation provided positive feedback, which by repetition of the algorithm execution, converges the ants in optimized paths, and finally, results in a response. The work process is in a way that each ant marks the distance between two nodes (cities) using pheromone, and in this way, increases desirability of a edge for the next selection. The amount of pheromone for this edge is displayed with the $\tau(i,j)$ parameter. In the beginning of each movement, equations (1) and (2) are utilized in order to determine the next step for *s*, while *k* shows the index for the ant residing in city *r*. Equation (1) is a greedy choice method based on the best possible combination from the distance and level of pheromone, and equation (2) balances this procedure by implementing a probabilistic selector.

$$S = \begin{cases} \arg\max_{u \in J_k(r)} \left\{ \tau(r,u) \lfloor d(r,u) \rfloor^{\beta} \right\} \; if q <= q0 & (Exploitation) \\ Equation 2 \quad otherwise & (Exploration) \end{cases} \tag{1}$$

$$P_k(r,s) = \begin{cases} \dfrac{\tau(r,s) \lfloor d(r,s) \rfloor^{\beta}}{\sum_{u \in J_k(r)} \tau(r,s) \lfloor d(r,s) \rfloor^{\beta}} & if \; s \in J_k(r) \\ 0 & otherwise \end{cases} \tag{2}$$

Parameter q is a random number in the range of [0, 1], which is determined based on a uniform distribution of possibility. Parameter q_0 is a constant value, which is used to adjust queries. A list of visited nodes is kept in the back of each ant, therefore cities that are not visited by ant *k* with the current location of *r*, are kept in list $J_k(r)$. In addition, β is a negative parameter that represents effect of distance. The higher value of *T(r,s)* meaning pheromone of a edge, increase the absorption rate of other ants in travelling that edge. After an ant passes a edge, the pheromone of that edge increases based on equation (3) [9].

$$\tau(r,s) = (1-\rho).\tau(r,s) + \rho.\tau 0 \tag{3}$$

In order to prevent rapid convergence of ants in one course, and falling in the trap of local optimal response, the term pheromone evaporation is used. Parameter ρ is used for this job. After completion of each repetition cycle of the algorithm, all ants have produced a complete tour, and it is time for a universal update. The universal update must be conducted in a way that the shortest distance be encouraged based on equation (4) [8].

$$\tau(r,s) = (1-\gamma).\tau(r,s) + \gamma.\Delta\tau(r,s) \tag{4}$$

$\Delta T(r,s)$ indicates the amount of pheromone rise in the best tour, which is obtained from equation (5). L is the length of the shortest tour until the end of the current repetition cycle, and Q is an evaporation constant parameter for the whole problem, and represents the quality of response. Y is the universal evaporation parameter of pheromone (0<Y<1).

3. Color space transformation

The purpose of the automatic face recognition process is to design a system that is able to detect faces in the image without user intervention. One of the main face detection processes is related to skin segmentation. The purpose of skin segmentation is image segmentation of input image to two parts of the skin and non-skin areas. Effort to streamline the process of skin segmentation is first, the input image space is converted from RGB to color space of HSI (Hue-Saturation-Intensity). HSI color space is a color space concept that offers convenient features of the input image. HSI color space allows us to perform skin segmentation process efficiently and accurately [3].To convert the RGB color space to HSI, a set of nonlinear equations are used (6, 7, 8). Positive features of HSI is that it separates the brightness component or the degree of Illumination of the image from other color components.

$$H = \mathrm{Cos}^{-1} = \frac{0.5[(\mathrm{R}-\mathrm{G})+(\mathrm{R}-\mathrm{B})]}{\sqrt{(R-G)^2+(R-B)(G-B)}} \qquad (6)$$

$$S = 1 - 3\frac{\min(R,G,B)}{R+G+B} \qquad (7)$$

$$I = \frac{1}{3}(R + G + B)$$

(8)

The main purpose of this conversion is to make the optical components changes of the image, independent from color components of the image.

This property enables face detection algorithm to detect faces in the input image independent from illuminating the input image.

4. The proposed system

A major function of face detection is separation of pixels belonging to the face skin fromthe rest of the pixels in the image. The general structure of the proposed technique is presented in Figure 1 The proposed method thus serves as follows: First, a color space conversion (RGB to HSI) is applied on the input image. This conversion makes it possible to easily separate facial pixels from other image resolution**.** After conversion, an ant classifier is used to assess whether the desired pixel belongs to the face or not. Given that in HSI color space, optical components are separated of the color image components. This option for the proposed method is provided to be independent of illuminating the input image attempt to search faces.

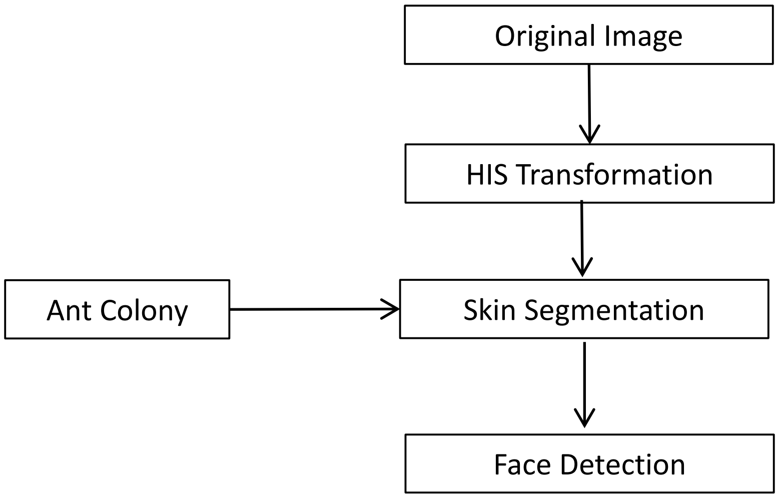

Figure 1 Overall structure of the proposed system

5. Ant colony algorithm for classification

To classify pixels in the face from the rest of the image parts, first, a matrix of pixels is used to keep the pheromones. The dimensions of this matrix are equal to the dimensions of the input image. Pheromone value stored in the matrix represents the fact that the corresponding pixel in the image is located at the border of face and the surrounding region. To specify the area or the border, a 3x3-slipper window is used. Note to Table 1. This window acts as a filter, and is moved on the image.

If there is a significant difference for pixels of the point the ant is located compared to adjacent points, then, the corresponding pixel pheromone is updated in the pheromone matrix. It should be noted that the desired window is moved several passes over the image to make the pixels. At the end of the algorithm, face can be identified based on the individual pixels of the desired area.

Table 1- How the ants move at the proposed algorithm

$P_{i-1,j-1}$	$P_{i-1,j}$	$P_{i-1,j+1}$
$P_{i,j-1}$	Ant	$P_{i,j+1}$
$P_{i+1,j-1}$	$P_{i+1,j}$	$P_{i+1,j+1}$

6. Experimental results

To evaluate the proposed face recognition systems, the Database ORL, IMM, Caltech and Bao are applied using the extracted images. Examples of images obtained from ORL database can be observed in Figure

2.ORL database contains 400 face images of 40 persons in different situations. Result of implementing the proposed algorithm on the images of extracted face from the mentioned databases can be observed in Table 1.As it can be observed in this table, the obtained result enjoys good quality.

Fig 2- Sample of images from ORL database

Table 2

Experimental results on the different face databases calculation detection rate percent

Database	Frontal	Near frontal
IMM[10] Number of images %Detection rate	60 92.2	40 94.9
Caltech[11] Number of images %Detection rate	80 93.9	- -
Bao[12] Number of images %Detection rate	40 91.1	20 92.9
ORL[10] Number of images %Detection rate	60 91.3	80 93.8

As it can be observed in Table 2, performance and accuracy of the proposed method on various databases is about 92.4 in the frontal mode and 93.9 in the near frontal mode.

7. Conclusion

In this paper, a new method is presented for detecting faces in an image. The proposed method first converts image space of RGB to HSI, making it possible for classifiers based on ant colony algorithm, to easily and accurately separate the face skin in the image from the rest of the face parts. Because the pixel values of this state are variable, therefore the proposed system is resistant against skin color changes of different races and light distribution in the input image. By implementing the algorithm on data obtained from different databases, it is concluded that the accuracy of the proposed algorithm with other methods in this field is equal and sometimes better.

References

[1] A. Pentland, B. Moghaddam, T. Starner, “*View-based and modular eigenspaces for face recognition*”, in Proc. IEEE Computer Society Conf. Computer Vision and Pattern Recognition, (1994), pp. 84–91.

[2] T. Cootes, K. Walker, C. Taylor, “*View-based active appearance models*”, in *Proc*. IEEE Int. Conf. Automatic Face and Gesture Recognition, (2000).

[3] V. Blanz, S. Romdhani, T. Vetter, "*Face identification across different poses and illuminations with a 3D morphable model*", in Proc. 5th Int. Conf. Automatic Face and Gesture Recognition, (2002) ,pp. 202–207.
[4] T. Cootes, G. Edwards, C. Taylor, "*Active appearance models*" in Proc. Eur. Conf. Computer Vision, vol. 2 (1998), pp. 484–498.
[5] V. Blanz, T. Vetter, "*Face recognition based on fitting a 3D morphable model*", IEEE Trans. Pattern Anal. Mach. Intell., vol. 25, no. 9 (2003), pp. 1063–1074.
[6] I. Matthews, S. Baker, "*Active appearance models revisited*", Int. J. Comput. Vis., vol. 60, no. 2 (2004), pp. 135–164.
[7] P.Kakumanu, S.Makrogiannis, N. Bourbaki, "*A survey of skin-color modeling and detection methods*", Pattern Recognition 40(3) (2007) 1106-1122.
[8] R. Shakerian, S. H. Kamali, M. Hedayati, M. Alipour, "*Comparative Study of Ant Colony Optimization and Particle Swarm Optimization for Grid Scheduling*", Journal of mathematics and computer Science (JMCS) Issue. 3 (2011) Pages: 469-474.
[9] Rouhollah Maghsoudi, Arash Ghorbannia Delavar, Somayye Hoseyny, Rahmatollah Asgari, Yaghub Heidari ,"*Representing the New Model for Improving K-Means Clustering Algorithm based on Genetic Algorithm*", Journal of mathematics and computer Science (JMCS) Vol. 2 Issue 2 (2011)**,** pp: 329 – 336.
[10] *http://www.facedetection.com.*
[11] *http://www.imm.dtu.dk.*
[12] *http://www.vision.caltech.edu*.