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Face Recognition Algorithm based on Image Gradient Compensation

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Abstract

With the rapid development of computer hardware, artificial intelligence and rapid rise, in the field of artificial intelligence, facial recognition as the image processing using artificial intelligence method of the most successful landing area, already has a large number of face recognition algorithm, this paper will talk about several kinds of common face recognition algorithms, and analyzes the advantages and disadvantages of each algorithm, and in the future,Face recognition technology needs to break through. Several common face recognition technologies include: convolutional neural network face recognition, face recognition based on edge computing, face recognition based on image gradient compensation, face recognition based on transfer learning, face recognition based on deep learning.

Keywords

Face Recognition; Deep Learning; Edge Calculation; Convolutional Neural Network; Image Gradient; Residual Network.

1. Introduction

Face recognition technology began to be studied in the 1960s, and the development of this field has experienced nearly 30 years. In 1990, Kanade's research group of Carnegie Mellon University in the United States and the research group led by PCNTland of Massachusetts Institute of Technology achieved good results in the field of automatic recognition [1], which has accumulated rich scientific research experience in this field. Face recognition is a hot topic in the field of computer image processing. There are two schemes usually adopted: one is to detect, recognize and extract the global features of the face [22], which can reflect the overall situation of the face. The second is to analyze and recognize the local features of the face. This scheme is used to extract the detailed information of the face, local binary (LBP) and scale invariant feature transform (SIFI) and gradient histogram (HOG). The emergence of deep learning provides a new idea for face recognition, namely convolutional neural network, which extracts different eigenvalues from the face, and then corrects each parameter in the model through the back propagation algorithm, and finally makes the judgment through the neuron output analysis [23]. Method for gradient algorithm described in this article, is to use the image shift to produce more [2] image gradient, using the algorithm of image gradient, gradient operator is to transform to compensate with the original image fusion, finally the characteristic values of the fused images are extracted, this algorithm is compared with traditional algorithm not only improve the recognition rate and efficiency is also very efficient. [3] were calculated based on the edge of facial recognition technology compared with traditional of CNN, its characteristic is to use a gateway to the nearest to deal with the related data and do not need to send the data to the cloud server, as this can help to reduce the pressure of the cloud server, and also can

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be used directly, which can identify the cloud and the gateway training data set can be sent to the cloud server, Enhance cloud recognition capability. The feature of face recognition technology based on transfer learning is to cut the face image in the traditional CNN network [4], remove the unnecessary part, and pass it into the MtCNN network, and then connect all the model parameters designed by ourselves to the MtCNN neural network model [5] to form a new neural network model. This method reduces the sample demand and network computation. It can not only quickly complete the training task, but also achieve satisfactory identification accuracy [6].

2. Face recognition compensated by gradient algorithm

2.1 Gradient of image

The gradient is not a real number, it's a vector, it has a magnitude and a direction, let's say a function of two variables $f(x,y)$ Its gradient at a point:

$$gradf(x,y) = \nabla f(x,y) = \{\frac{\partial f}{\partial x}, \frac{\partial f}{\partial y}\} = f_x(x,y)\bar{\imath} + f_y(x,y)\bar{\jmath}$$

After sorting out:

$$(\frac{\partial f}{\partial x}, \frac{\partial f}{\partial y})^T$$

It's essentially its directional derivative, the direction in which the function changes the fastest is in the direction of the gradient, and it's easy to find the maximum along the gradient.

Let's make the monochromatic image at any coordinate (x,y) The intensity (gray scale) at is expressed as $f(x,y)$ I take the derivative of x and y

$$\frac{\partial f(x,y)}{\partial x} = \lim_{\varepsilon \to 0} \frac{f(x+\varepsilon, y) - f(x,y)}{\varepsilon}$$
$$\frac{\partial f(x,y)}{\partial y} = \lim_{\varepsilon \to >0} \frac{f(x, y+\varepsilon) - f(x,y)}{\varepsilon}$$

The function of the image is a two-dimensional discrete function, so the limit cannot be taken as a mathematical formula. The minimum pixel value 1 is used to replace the limit approaching 0 in the formula, and Formula (2) and (3) can be converted into

$$\frac{\partial f(x,y)}{\partial x} = f(x+1, y) - f(x,y) = gx$$
$$\frac{\partial f(x,y)}{\partial y} = f(x, y+1) - f(x,y) = gy$$

$G_{rx}$is the right gradient of the horizontal direction, and G_{lx} is the left gradient of the horizontal direction. Its calculation formula is as follows:

$$G_{rx} = |f(x+1, y) - f(x,y)|$$
$$G_{lx} = |f(x,y) - f(x-1, y)|$$

G_{uy} is the upper gradient in the vertical direction, G_{dy} is the lower gradient in the vertical direction, and its calculated fraction is:

$$G_{uy} = |f(x, y-1) - f(x,y)|$$
$$G_{dy} = |f(x,y) - f(x, y-1)|$$

The sum of the left gradient and the right gradient in the horizontal direction is defined as the horizontal composite gradient of the image, denote as:

$$G_{hor} = G_{rx} + G_{lx}$$

The sum of the upper gradient and the lower gradient in the vertical direction is defined as the vertical composite gradient of the image, denoted as:

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$$G_{ver} = G_{uy} + G_{dy}$$

The sum of the upper gradient and the lower gradient in the vertical direction is defined as the vertical composite gradient of the image, denoted as:

$$G_{hs} = G_{rx} - G_{lx}$$

The difference between the upper gradient and the lower gradient in the vertical direction is defined as the difference gradient in the vertical direction of the image, denoted as:

$$G_{vs} = G_{uy} - G_{dy}$$

The sum of the horizontal synthesis gradient and vertical synthesis gradient of image A is defined as the fusion gradient of image A, denided as:

$$G_{fusion} = G_{hor} + G_{ver}$$

The sum of the difference gradient in horizontal direction and the difference gradient in vertical direction is defined as the difference fusion gradient of image A, denoized as:

$$G_{subfus} = G_{hs} + G_{vs}$$

2.2 Image gradient compensation IGC algorithm

The process of the algorithm can be summarized as follows: First, image features are extracted by IGC algorithm, then the image is divided into multiple 3×3 template sub-graphs, and the gray level of each sub-graph is statistically histograms to form feature vectors. PCA is used to reduce dimension. Finally, vector machine is used for classification training and recognition [7].

2.3 PCA dimension reduction

The image feature vector obtained by IGC algorithm still has a high dimension, which may reach more than 1000 dimensions, which is not conducive to the image recognition effect [8], and it will take more time and storage resources to train the model with high dimension. Therefore, PCA technology is used for dimensionality reduction. PCA technology theory of the core is to find a set of orthogonal coordinate axes, and thus find out or variance biggest axis coordinate system to the original data, until find out n coordinate axis, the axis before K contains most of the variance, and then the coordinate axes is almost variance is zero, so K before extraction of coordinate axes as a feature vector [9], The purpose of dimensionality reduction for higher dimensional vector is realized.

3. Convolutional Neural Network Face Recognition

3.1 Introduction to Convolutional Neural Networks

The structure of convolutional neural network is similar to the traditional form of neural network. It belongs to the multi-level network structure and contains a large number of neurons in each layer. It can be regarded as a simulation of the neural structure of human brain. It mainly contains three parts: one is the input layer, the second is the pooling layer and the n-layer convolution layer, and the third is the fully connected multilayer perceptron classifier. At present, Convolutional Neural Network is a hot topic in large enterprises and high efficiency research.

3.2 The basic structure and working principle of convolutional neural network

A typical convolutional neural network is mainly composed of five parts: the input layer, the convolutional layer, the lower sampling layer (pooling layer), the full connection layer and the output layer. The following figure is the construction of Lenet-5 Convolutional Neural Network.

The work flow of convolutional neural network can be divided into the following three steps: definition, training and testing. Definition is the definition of the convolutional neural network model, which needs to be defined according to specific experiments and data characteristics [20]. Training is a process in which parameters in the model are modified by the back propagation algorithm, and a trained model is obtained by substituting these parameters into the existing model. The test is to first pass the data set into the model for pre-processing [10], and then reach the output layer through

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forward conduction. The output layer will make judgment by the value of the neuron and then classify the category.

4. Image gradient compensation IGC algorithm

4.1 Architecture

Edge computing [11] refers to replacing the cloud server with a gateway to train the training data set, and then returning the training results to the cloud server or end-users, so as to avoid excessive load and delay caused by too many requests or too much data on the cloud server.So the system structure design of edge computing should include two parts: the development of the edge side system and the development of the server side. This system will collect data through the camera in the edge segment and send the data packet to the cloud server. The edge management platform will be used on the server side to train the face image, and the final trained model will be saved to the server [12]. When face recognition is used at the edge end, the training model is downloaded from the cloud server for recognition.

The edge end uses Yue embedded GEC3399 artificial intelligence [17] embedded development board, configuring Ubuntu16 operating system, and configuring OpenCV visual library of ARM version at the same time. The edge end uses the camera to collect the face data, and then uses OpenCV to grayscale the face image [18], and transfers the grayscale image after processing to the server end.

The operating system [13-16] is Ubuntu16 of server-side, with OpenCV, QT andarm-linux-gcc[21].

4.2 Implementation of gradient compensation algorithm

Read the image and convert it to grayscale image to obtain the matrix A of order M × N of the image.

Step 1: Generate the offset matrix

Move all the elements of matrix A up 1 bit in the positive direction of the Y axis to form the matrix GT1.

Step 2: Obtain the image gradient

To extract the contour information in the image, we set the vertical direction upwards.The gradient $G_{uy} = |A - G_{t1}|$ at this point, if the pixel matrix A and its line of pixel values within the same column on the same or similar, after the operation has A value of 0 or A very small number, if the pixels in A row with the column of pixels with the value of the [19], there is A big gap indicates that the pixels is likely to be the outline of the image, the value after the absolute value computation is positive, can reflect the image contour.

Step 3: Extract the mergence gradient.

The above horizontal left and right gradients are accumulated as shown in Equation [11] to obtain the horizontal synthesis gradient G_{hor}; the upper and lower gradients in the vertical direction are accumulated as shown in Equation (12) to obtain the vertical synthesis gradient G_{ver}. Then, G_{hor} and G_{ver} are accumulated to obtain the matrix fusion matrix G_{fusion}.

Step 4: Denoise G_{fusion}.

There are many scattered points in G_{fusion} generated by the above process, and most of these scattered points are not characteristic information related to the image contour. In order to eliminate the influence of scattered points, an appropriate algorithm is used to de-noise the matrix.

Step 5: Extract the differential fusion gradient

Extract the horizontal and vertical difference gradients;

Extract the image difference fusion gradients

Step 6: Generate eigenvectors

1. G_{fusion} matrix is used to make positive compensation for matrix A to obtain A new matrix G_m

$$G_m = A + G_{fusion}$$

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2. Use G_{subfus} to make negative compensation for G_m

Step 7: Block the above feature matrix G_{fig} with a specific template, and conduct histogram statistics on the pictures of each block, and then connect the histograms of each block in a certain order to form feature vectors.

5. Conclusion

Through the understanding of various face recognition algorithms, it can be seen that in the field of face recognition, the most popular is deep learning, that is, the use of convolutional neural network to recognize. Convolution neural network also has a lot of versions and change today, so if you want to continue on the recognition accuracy and speed of the neural network improved, need to understand a lot of knowledge or, at the same time as a result of the neural network is a very complicated system, individuals to achieve a more accurate and practical neural network is very difficult, Now all of the tools are built in the forefront of high-tech enterprise based on the designed neural network for some parameters to improve and adjust the, subversion and transcend the existing technology there are a lot of difficulties, but as far as the present stage, the accuracy of neural network is very high, only the computation is not generally the host can be, It needs to be carried out on a server with multiple high-speed CPUs and GPUs. Therefore, the problem to be solved is how to deal with the centralized storage of data and improve the speed of data operation and data transmission on the cloud server.

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