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Human gait recognition for Multiple views

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Abstract

Gait recognition is a promising topic in the biometric technology. The technique identifies individuals based on their walk style. Gait energy image combines frames of one gait cycle together to enhance the relevance among them, to reduce the noise interference. In this paper, Fourier transform was carried out on the gait energy image. Their low frequency components were adopted to perform multi-view gait identification. The method was applied to CASIA database. The experiment results demonstrate that the proposed method is fast and effective.

Keywords: gait recognition; gait energy image; Fourier transform; multiple views

1. Introduction

As increasement of security awareness, people want to use the more convenient identification methods on human recognition. Biometrics responses to this demand,. In biometrics research, the gait recognition is the only way to identify human at a distance.

Gait recognition is used to identifies the people through their walking attitudes. Its advantages are: 1) Uniqueness. Each person's trait, such as bone length, bone density, the damage extent of bone and other physiological conditions, is different, so gait is unique. 2) It behaves non-contact, non-invasive, little affected by the environment. 3) It is easy to observe, not easy to hide and difficult to disguise. 4) The demand of image resolution is less. People can detect low-resolution image sequence for identification. Gait research has wide application prospects in medicine, psychology, video surveillance.

Gait is affected by many factors, such as clothing, backpacks, health status, mental status. The angle of the camera has the impact on gait identification. They makes the gait recognition as a challenging issue.

Broadly, gait recognition methods can be divided into model-based methods and model-free methods. Model-based methods [1,2,3] focus on deriving the body or leg movement. It is modeled with human anatomy knowledge to study the movement of various body parts, and to obtain measurable parameters, such as the body center, the limbs direction, head direction. Model-free methods [4,5,6] do not need prior modeling. It directly operate on the image sequence to capture gait characteristics. Model-based

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approaches are a little affected by the perspective, but time-consuming is large because each frame need be identified. Time-consuming of model-free method is small, but the impact effect by the angle is large.

This paper used model-free method for multi-view gait recognition research.

2. Feature Extraction and Recognition

2.1. Image Preprocessing

Gait sequence data is large, but the early stages of gait recognition only need identify the person who walk, so the image can be divided into the prospects of gait (the pedestrian) and the background. The purpose of preprocessing is to remove the background, only to retain the walker. Common methods include background subtraction method, frame difference method, optical flow method. In this paper, the background subtraction method is used in extracting moving object. During extraction, noise and small hole may occur, so morphological operators need be used.

Processing steps are:

(1) The background subtraction method is used to extract the moving object.

(2) Morphological operators are used to remove noise and small holes.

(3) The images are normalized. The normalized size is 128x40.

The results are shown in Figure 1.

Fig. 1. (a) An image before preprocessing; (b) An image after preprocessing

Fig. 2. An example of GEI

2.2. Cycle Detection

Walking behaves periodic. After preprocessing images, the data of gait image sequence is still great. The testing of the gait cycle sequence is necessary. It not only can reduce the amount of data for being processed, but also for analysis and identification.

Cycle detection methods can be divided into two categories. A method is based on changes in image sequences to find a regular cycle. Walking is mainly because the movement of the legs. Lam [6], Sarkar [7] obtain a gait cycle according to the change number of the leg silhouette pixels. Another method directly provide a specified digit as a cycle number, such as Zhang [3] assign 32 as a walking gait cycle.

Because the speeds of the pedestrian are different, it is unreasonable that all the testers use the same frame as the gait cycle, so different tests should use different frame number as the gait cycle. Gait image sequences can be found in the corresponding variation of the cycle number. In this paper, autocorrelation is used to detect periodic[8].

$$N_g = \arg \max_{N\in[N_{\min},N_{\max}]} C(N) \quad (1)$$

$$C(N) = \frac{\sum_{x,y}\sum_{n=0}^{T(N)} I(x,y,n)I(x,y,n+N)}{\sqrt{\sum_{x,y}\sum_{n=0}^{T(N)} I(x,y,n)^2}\sqrt{\sum_{x,y}\sum_{n=0}^{T(N)} I(x,y,n)}} \quad (2)$$

Where, Ng is the gait cycle. C (N) is autocorrelation gait. I (x, y, n) denotes the n frames at the (x, y). The definition of T(N) is Total -N-1. Total is the number of frames in the gait sequence. Based on the large number of experimental, we set Nmin = 15, Nmax = 35.

2.3. Feature Selection

According to the number of frames used in feature extraction, gait recognition methods can be divided into single-frame-based method and cycle-based method. Single-frame-based approaches extract feature from each separate frame, and then organize the required features of every frame together to constitute a feature vector. These method can observe the trend of the image and characteristics of gait; but their disadvantage is vulnerable to the impact of noise on image and requires high quality silhouette images. Cycle-based approaches first superimpose image sequence based on a cycle, then extract features. The advantage is that the noise of individual image has small impact on the result. The drawback is that only the characteristics of a cycle can be observed, can not distinguish the trend of gait characteristics sequences.

Gait is cyclical, so the interframe correlation can be considered. Cycle-based approaches include typically motion energy image [9] (MEI), motion history image (MHI), gait energy image [10] (GEI), gait history image [11] (GHI). MEI and MHI are concerned about the dynamic part of the walk. Not only the gait dynamic part and also the gait static part include the important characteristics of gait. Gait energy image fits well with this feature, so this paper used this method to extract characters. Gait energy image of a person is defined as follows:

$$G(x,y)=\frac{1}{T}\sum_{t=1}^{T}I(x,y,t) \qquad (3)$$

Where, t is time of gait image. T is a gait period. G (x, y) is gait energy image. Gait energy image is a grayscale image, as shown in

The discrete Fourier transform of a two-dimensional image:

$$\mathrm{F}(u,v)=\sum_{x=0}^{M-1}\sum_{y=0}^{N-1}f(x,y)e^{-j2\pi(ux/M+vy/N)} \qquad (4)$$

Where f (x, y) is a MxN image.

The frequency of image indicats image gray variation intensity, and is gray gradient in the plane space. Fourier transform of the image transformes the image gray distribution function into the image frequency distribution function. Images energy mainly distributes in the low frequency domain, so this paper uses 48 low-frequency spectrum as gait characteristics.

2.4. Classification and Recognition

There are many classify ways, including nearest neighbor (NN), support vector machine (SVM), artificial neural network (ANN), dynamic time warping (DTW), hidden markov model (HMM). The focus of gait recognition is feature selection, most papers uses nearest neighbor classification.

Because the focus of this paper is to observe the effect of the Fourier transform of gait energy image on multi-view gait recognition, this paper uses nearest neighbor classifier.

3. Experimental results and analysis

This paper uses the CASIA Dataset B database. Dataset B is collected in the indoor environment. In the dataset, image sequences of 124 individuals are captured under 11 views (0,18,36,54,72,90,108,126,144,162,180 degrees). 10 sequences per person per views are recorded, of which 6 sequence is under the normal walking conditions, 2 sequence is under the different clothes

walking case, 2 sequences is under the knapsack walking condition. This article uses 6 sequences under normal walking cases. This database acquisition speed is 25 frames per second with a resolution of 320 X 240.

Four sequences is randomly choosed as the training group, the remaining two sequences as the test group. The experiment executs 15 times. Correct classification rate (CCR) is shown in table 1.

Table 1: The Recognition Rate of Gait

		Test Groups										
		0^0	18^0	36^0	54^0	72^0	90^0	108^0	126^0	144^0	162^0	180^0
Training Groups	0^0	76%	20%	12%	10%	13%	12%	13%	12%	11%	37%	70%
	18^0	11%	79%	52%	32%	55%	46%	56%	45%	37%	59%	21%
	36^0	14%	56%	74%	60%	79%	78%	74%	72%	60%	31%	14%
	54^0	11%	37%	62%	80%	63%	63%	55%	66%	54%	19%	10%
	72^0	14%	57%	76%	58%	81%	77%	72%	69%	55%	33%	15%
	90^0	13%	49%	74%	61%	77%	83%	67%	71%	60%	28%	13%
	108^0	15%	59%	75%	53%	74%	73%	75%	69%	57%	34%	14%
	126^0	13%	49%	71%	65%	72%	75%	69%	73%	63%	28%	13%
	144^0	15%	51%	71%	66%	69%	73%	69%	75%	64%	28%	14%
	162^0	40%	56%	28%	17%	30%	26%	31%	25%	20%	75%	34%
	180^0	67%	18%	11%	10%	11%	11%	12%	11%	9%	29%	79%

They can be seen from table 1: (1) The recognition rate is highest when the test view and training view is same. (2) The correlation between the degree of 0 and 180 is large, the relevance between the degree of 162 and 18 is relatively large, the correlation between the degree of 18 and 36,72,108,144,162 is relatively large, and the correlation between the remaining 7 view (36,54 , 72,90,108,126,144) is large.

4. Conclusion

In this paper, the Fourier transform of gait energy image is used to extract gait features and the nearest neighbor classification for identification. This method is less time-consuming, and fast speed. In this paper, the projection transformation is not used to extract the characteristics of identification, therefore it need explore the perspective projection transformation on the effects of gait recognition.

Gait recognition research has significant application and also requires an in-depth study.

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