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Human Gait Recognition based on Earth Movers Distance and Zernike Moments

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Abstract

In this paper, the Gait recognition includes the following stages: In stage of moving target detection, this paper uses the background subtraction to extract gait silhouette. In stage of feature extraction, using Key frame technology and Zernike Moments to extract silhouette feature. According to obtain feature data, we can use Earth Movers Distance (EMD) to recognize gait sequence.

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Keywords: Zernike moments;The random forest classifier ;Earth Movers Distance

1. Introduction

Gait is a complex behavioral characteristics, which is the people walking posture. Gait has uniqueness because it has the differences of people in height, weight, muscle, bone, physical, individual profile and sensitivity, flexibility. Gait is the unique biological characteristics with remote sensing nature. Authentication based on gait characteristics is a hot topic of research in recent years. Gait recognition refers to recording authorized person gait image by the camera. When some person is close, the camera automatically recorded walking posture through matching method to confirm its identity. Gait Recognition widely involve in computer vision, pattern recognition, artificial intelligence, video processing and many other subjects. With the rapid development of technology, gait recognition has wide application prospects and economic value in the field of health care, intelligent monitoring and gait analysis.

Currently, a large number of scholars conduct depth research for gait recognition problem and made a series of algorithms. Among the literature, many gait recognition methods have been proposed, which is *KNN*, *SVM*, *HMM* training algorithm and *DTW* recognition matching algorithm.

The [1] propose a novel feature extraction method of the triangle model legs and using *KNN* training algorithm, which improve the system recognition rate. Shuttle et al [2] propose a statistics gait recognition algorithm based on the time moment in one of four people on a small database to obtain 100% recognition rate. The [3] use *HMM* training and recognition matching algorithm in *CASIA* databases and obtain good recognition. The [4] propose a direction histogram *HOG* feature of the human body, combined with linear support vector machine SVM classifier detected human region. Then use the particle filter method human tracking, and finally the use of multi-feature fusion method improves the recognition rate. The [5] use the width vector of the side contour as gait characteristic of the human body binary image and use *HMM* (Hidden Markov Model) classification and recognition. Kale [6] propose a method of width foot human outline to extract gait feature, using Dynamic Time Warping match with test feature vector sequence and sample sequence.

In this paper, we use median background modeling method to establish background with the sequence of videos. Then we use background subtraction to extract moving target silhouette and pre-treatment moving target image. Next, we extract the contour of moving object. The speed of the system is very slowly because many frames are extracted of the moving object sequence. We use silhouette aspect ratio to determine key frames of the motion sequence and use Zernike moments to extract feature. After feature extraction, we establish gait

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database and use Random Forest algorithm training template library in order to improve gait recognition rate and accuracy rate. Finally, we carry out matching recognition with the Earth Movers Distance (*EMD*) algorithm.

2. Gait recognition technology

2.1. Moving Object Segmentation

The target detection is that detect silhouette from image sequence. To use background subtraction method [7], we must be background modeling firstly.

2.1.1. Background modeling

In this paper, we adopt the median modeling method [8] to background modeling. We take the successive N frames images over a period of time. Then in the N frames images, we arrange gray value of corresponding position pixels in descending. Using intermediate value as background image corresponding pixel gray value, background image is the set of pixels.

Assumed that the image size is $n * n$, it(x, y) is the pixel value of the t-th frame image in the (x, y) point. The value of m frame image corresponding pixel point is stored in the array[n]. Then [t] = it (x, y), t = 0, 1 ... m, Array [n] is arranged in descending in order to obtain median as a background image. According to the above method, background image is obtained by processing the image sequence. The Fig.1 is the established background image.

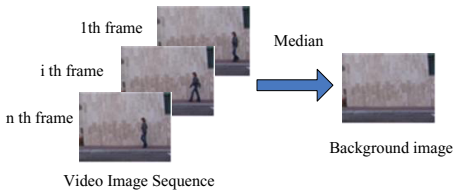

Fig.1 Background modeling

2.1.2. Target Detection

We use each frame f_k (x, y) in image sequence to subtract background model B_k (x, y), then we get the difference image D_k (x, y) and it is putted into effect binary processing. Finally, we select the appropriate threshold T and using the threshold processing to process the difference image. It uses (2) to determine whether the former point. All former points constitute of silhouette.

$$D_k(x,y) = |f_k(x,y) - B_k(x,y)| \quad (1)$$

$$p_k(x,y) = \begin{cases} 1 & \text{foreground}, \ D_k(x,y) \geq T \\ 0 & \text{background}, \ D_k(x,y) \geq T \end{cases} \quad (2)$$

The fig.2 (a) is obtained silhouette image which has many noises. If we want to obtain the complete closure region, we must use morphological to the fig.2 (b). Finally, we obtain the fig.2(c). We use canny algorithms to extract the target contour line and obtain the Fig.2 (d).

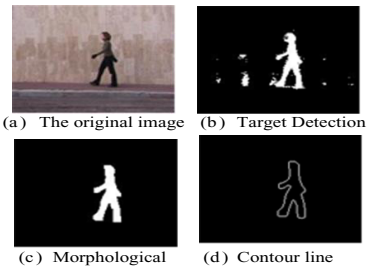

Fig.2 Background modeling

2.2. Feature Extraction

2.2.1. Periodic Detection

Human walking movement is duplicate in a particular frequency [9] and, and therefore gait has periodicity. In this paper, aspect ratio of the human body outline is used to get on gait cycle analysis.

For each frame of human silhouette image, we set a minimum rectangle which can contain the whole silhouette line. It can obtain width and height of human silhouette line. By calculating the each frame aspect ratio in the sequence, we can get gait cycle of the movement silhouette. The gait cycle curve similar to the sinusoidal curve and has obvious periodicity. The Fig.3 is the Single sequence gait cycle.

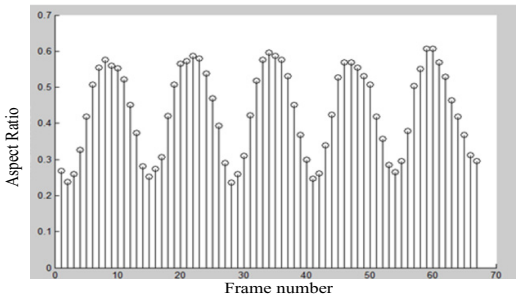

Fig.3 Single sequence gait cycle

In order to eliminate the influence caused by the length of the image sequence, to ensure that comparative classification in a fixed pattern and reduce the computational complexity, we extracted five key frames feature in one cycle. In the paper, we adopt extreme detection to extract key frame. The Fig.4 is the 5 key frames [10] selected.

Fig.4 Single sequence key frame

2.2.2. Zernike Moments

Zernike Moments [11] is a complex set of radial orthogonal polynomials, which is a more mature orthogonal invariant moments. Zernike moments can construct any