

Study and Analysis of Human Gait to Recognize the Person

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Abstract: *GAIT is a way of moving on foot. Identification of an individual by the manner of walk is called Gait Recognition. Gait has some properties which make it so attractive like it is unobtrusive biometric, which offers identification of person at a distance, no interaction is required from the subject. This present work proposed a method for Gait recognition. In this method firstly frames has been created from video sequences of walking persons. Secondly background subtraction, silhouette creation and feature extraction is done using image processing operations. This present work uses key features centre of gravity, length of step size, mean intensity, perimeter, diameter, width, height and centroid. Here all experiments are done on CASIA Gait database [10] and captured video sequences using digital camera. For the implementation of biometric technology with Gait analysis has caught attention in all over the world. There are many advantages like low quality data analysis, identification at the distance, poor illumination etc. which makes Gait based biometric a better system than other human biometric traits.*

Keywords: Human identification, Artificial Neural Network (ANN), Soft Computing, Gait Recognition System (GRS), Centre of Gravity.

1. Introduction

Biometrics is the technology and science of analysing and measuring data related to biological. In IT field biometrics refers to technologies that analyse and measure characteristics of human body such as finger print, irises, voice and facial pattern, hand measurement(for authentication purpose), DNA etc. They are physiological and behavioural. The new addition in biometric identification technology is Gait recognition which identify person by the way of walking.

Johansson [1] had shown in the 1970's that observers could recognize walking subjects familiar to them by just watching video sequences of lights affixed to joints of the walker. Hence, in theory, joint angles are sufficient for recognition of people by their gait. However, recovering joint angles from a video of walking person is an unsolved problem.

An effective representation of silhouette for gait recognition is developed and statistical analysis is performed [2]. The idea presented here implicitly captures both structural (appearances) and transitional (dynamics) characteristics of gait. The silhouette based method presented is basically to produce the distance vectors, which are four 1D signals extracted from projections to silhouette, they are top-, bottom-, left-, and right-projections.

Yi-Bo Li et. al. [3] has proposed general method and development actuality of gait recognition. They described three methods of gait recognition, which include statistical based method, model based method and fusion based method. The statistical based method characterizes body movement by the statistic of the space temporal pattern generated in the image sequence by the locomotive person.

The advantage of this method is the ability to drive gait signature from model parameter and free from the effect of the different clothing and view point. However, it is time

consuming and costly [4]. Fusion is combination of both statistical and model based method.

In work[5] presents a method based upon spatio temporal silhouette analysis measured during The process of human identification using gait shape includes capturing of walking subject using high resolution cameras. Then Videos are segmented and background is subtracted. The images are cropped and silhouettes are generated. This includes at least one complete gait cycle to recognize a person.

In [6] Samangoeei et.al. have introduced the use of semantic human descriptions as queries in content based retrieval against gait signatures. They successfully used them return an ordered list of un-annotated subjects based on their gait signatures.

In [7] Jang-Hue Yoo and M.S.Nixon proposed a new method for automated marker less system to analyze and classify human gait motion by using a set of 2D stick figures to represent the human gait motion and the features parameters are determined from the sequence of extracted gait figures. A K-nearest neighbour classifier is used to classify the gait patterns.

2. The Proposed Method

This paper proposed a new method of Gait recognition. The method is as follows:

2.1 Frames and Silhouette Creation

The frames must be created before getting the silhouette image. Here frames have been created from a captured video sequence. Background subtraction is used for getting silhouette of an image.

Step-1) Biometric recognition like finger impression, facial recognition etc require interaction of person for identification. Present work does not need any interaction of person it only

needs a video of walking person. Initially the video sequences of walking persons has been taken from a digital camera from a specific distance with a specific angle which is stored in hard disk of system in avi format. The present work also uses image frames from CASIA database.

Step-2) The video sequences are converted into the frames (movable images to still images). Conversion of the frame required as dealing with video is a complex and time taking. It is easy and simple working with frame as compared with video.

Step-3) The individual silhouette must be detected before getting the gait features. In the present work the camera is assumed to be static and that the body in the field of view is not occluded from each frame. To obtain an approximate background from the image sequence of a walking people, first mean image is computed by averaging the gray-level at each pixel over the entire image sequence.

Image processing operation likes Erosion, dilation can be applied to improve the quality of extracted silhouette, and reduce noise.

Step-4) Now the silhouette boundary box is created. Silhouette boundary box is created so that the whole object can be covered from outside and its right edge boundary touches the back foot back end and left edge touches the front foot front end.

3. Features Extraction

For identification processes any video sequence of a walking person is given as input in this first captured video sequences are given as inputs then the frames (still images) are created and background subtraction process is done. After background subtraction the silhouette is created using boundary box technique. Then target frame (the frame which has maximum length of step size) has been chosen for further processing. Feature extraction is done on the target frame in this process various key features has been extracted and at last these features are saved in the dataset of database.

If working on CASIA dataset above first three steps are not required silhouette images can directly created from CASIA images and can get the features for dataset.

Following is the stepwise explanation of above process:

Step-1) unlike other biometric identification present work does not need any interaction from walking person, only video sequence of walking person is required. For the present work walking persons videos has been captured with specific static angle and with a particular distance from a digital camera and these video sequences are stored in hard disk computer system in avi format. The present work also uses the CASIA database frame images that are also stored in system.

Step-2) The video sequences are converted into frame. The present work works with frame to reduce complexity which can be an issue while working with videos. The individual binary silhouette must be detected before getting the gait features. To obtain an approximate background from the image sequence of a walking people, first mean image is computed by averaging the gray-level at each pixel over the entire image sequence.

Let $I_k(x, y)$, $k=1, 2, \dots, N$, represent sequence of N images.

Back ground images $b(x,y)$ can be computed by

$$b(x,y) = \text{median} (I_k(x,y)), k=1,2,\dots,N \quad (1)$$

Moving object is extracted by back ground subtraction.

Now the silhouette boundary box is created. Silhouette boundary box is created so that the whole object can be covered from outside and its right edge boundary touches the back foot back end and left edge touches the front foot front end.



Fig.(a) Fig.(b) Fig.(c)

Figure 1: Example of gait detection. (a) Background image; (b) Original image; and (c) Extracted boundary box silhouette.

In human gait recognition system feature extraction is the very important task. It should be robust to the varying conditions and capable of identifying the individuals.

Step-3) After getting binary silhouette box, the frame which has maximum width has been selected and all the feature extraction operations are performed on that frame. This particular frame is called target frame. Figure 2 shows the detection of height and width.



Figure 2: Detection of height and width of a frame

Step-4) The image which analyzed are stored in the form of two-dimensional data array, in which each datum is referred to as a pixel (picture element). The present work refer an individual pixel located at row i and column j by the notation. After getting the target frame following is the process of calculating all the feature of target frame.

Mean Intensity : An image may be defined as two dimensional light intensity function $f(x, y)$ where x and y denote spatial co-ordinate and the amplitude or value of f at any point (x, y) is called intensity or gray scale or brightness of the image at that point. The mean of these pixel values is the mean intensity.

Area : In the present work area which is the number of white pixels in target image frame represented by A , is the area of region, it can be calculated by following formula-

$$A = \sum_{i=0}^m \sum_{j=0}^n B(i, j) \quad (2)$$

Where $B(i, j)$ = the brightness of the image at the point (i, j)

Centroid(center of mass) : At the time of walking ,the human body center of mass change from instance to instance so we can use center of mass as a feature this center of mass show the brighted weighted average of x and y coordinates pixels in the frame. Center of mass of the white pixels area for binary images is the same as the center of mass if we consider the intensity at a point as the mass of that point. In binary image we can calculate center of mass coordinate by using following formula:

$$\text{Centroid} - X = \frac{\sum_{i=0}^m \sum_{j=0}^n j \cdot B(i, j)}{A} \quad (3)$$

$$\text{Centroid} - Y = \frac{\sum_{i=0}^m \sum_{j=0}^n i \cdot B(i, j)}{A} \quad (4)$$

Here x and y are center of mass points in image and m and n is dimension of matrix which store image in matrix form, A is the area of region and calculated by equation 2.

Diameter : The diameter of an image is any straight line segment that passes through the center of the image and whose endpoints lie on inside (boundary line) of the image.

It can be also defined as the longest chord of the image.

In the present work following formula has been used to calculate diameter in target frame :

$$\text{Diameter } d = \text{square root } (4 A / \pi) \quad (5)$$

Where A is the area of region and calculated by equation 2.

Width and Height : Width and Height can be calculated using boundary box technique as shown in figure 2 .

4. Recognition System for gait

Gait recognition system for present work, works in two phases as shown in figure 3 (a) and (b). Figure (a) shows the first phase of process that is dataset creation process. In this first captured video sequences are given as input then the frames (still images) are created and background subtraction process is done. After background subtraction the silhouette is created using boundary box technique. Then target frame (the frame which has maximum length of step size) has been chosen for further processing. Feature extraction is done on the target frame in this process various key features has been extracted and at last these features are saved in the dataset of database.

If working on CASIA dataset above first three steps are not required silhouette images can directly created from CASIA images and can get the features for dataset.

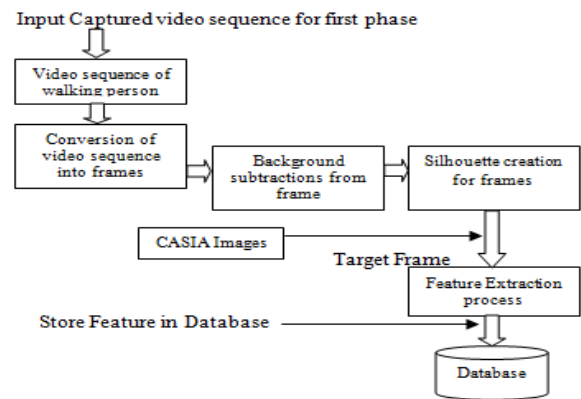


Figure 3: First Phase of Gait recognition system

Figure (b) shows the second phase of the system that is the matching phase. In this first five steps are same as first phase captured video sequences are given as input then the frames are created and background subtraction process is done. After background subtraction the silhouette is created using boundary box technique. Then target frame has been chosen for further processing. Feature extraction is done on the target frame in this process various key features has been extracted and at last these features are matched with the dataset created in the first phase. If all features are matched of a person means person has been recognized successfully otherwise that persons details are not in our dataset. If working on CASIA dataset above first three steps are not required silhouette images can directly created from CASIA images and can get the features for dataset.

Input Captured videos sequence for Second Phase

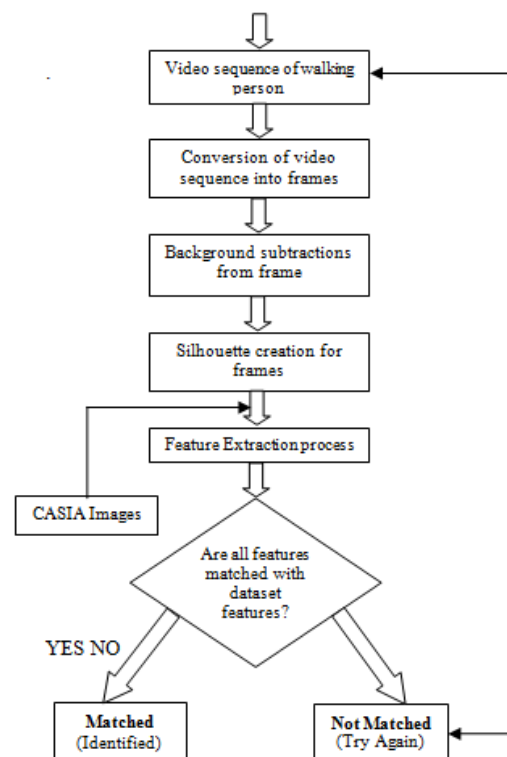


Figure 4: Second phase of Gait recognition system

Table 1: Datasets

Source	Video Sequences of person			CASIA database frames of person			
	P1	P2	P3	P4	P5	P6	P7
Person (Subjects)							
Mean Intensity	255	255	255	249	248	248	249
Area	1808	1560	2107	2337	1169	1434	1042
Perimeter	376.2082	378.5929	414.8356	355.4222	222.6224	1224.1227	333.3
Centroid	X	21.1272	21.7583	22.9620	31.5	24.2	27.1
	Y	64.3794	60.6994	65.4514	54.5	25.4	42.7
Diameter	47.9793	44.5674	51.7949	54	25.3	27	20.6
Width	46	42	49	53	44	49	54
Height	120	111	119	102	52	55	44

5. Experiment and Result

We performed experiment on different datasets. This dataset is divided into 2 set, first contains the video sequences frame feature and second contains CASIA database frames features as shown in table 1. Each contains the silhouette and extracted features from different person's walking frame. Experiments performed on Matlab. The results show that this technique may be proved as one of the effective tool for human identification and surveillance in future.

6. Conclusions

Gait recognition is one kind of biometric technology that can be used to monitor people without their cooperation. Controlled environments such as banks, military installations and even airports need to be able to quickly detect threats and provide differing levels of access to different user groups.

7. Future Scope

Due to increasing crime rate vision based human identification at a distance has recently gained wider interest from the computer vision community. Such applications are useful in security-sensitive environments such as banks, parking lots, and airports. This work can be extended to new biometric system in which gait can be combined.

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