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Human Gait Recognition using All Pair Shortest Path

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Abstract. The reliable extraction of gait features from image sequences is an important issue in gait recognition. This paper presented a simple, but efficient approach to extract gait feature. A new algorithm is proposed which is based on graph of all pair shortest path distance. Consider 4 frames which complete human gait cycle. Select 4 points i.e palm, knee, ankle and toe. All frames are connected to another frame using these four points and the graph is formed. These four points are node of the graph. Compute the euclidean distance between the points or nodes. calculated euclidean distance is a weight between two nodes, by using these weights the All Pair Shortest Path distance is calculated. Recognition is achieved by matching shortest path distance of input images with the database. Only the side-view of the person is considered, since this viewing angle provide the richest information of the gait of the waking person. The experimental result shows that the proposed approach has a good recognition performance.

Keywords: gait recognition, euclidean distance, shortest path.

1. Introduction

Gait recognition is a kind of biometrics using the manner of walking to recognize an individual. "Gait recognition refers to automatic identification of an individual based on the style of walking" [1]. It is well-known that biometrics is a powerful for reliable automated person identification, but at present, none of the conventional biometrics like fingerprint recognition, iris recognition can work well from a large distance [6]. The distances between the cameras and the people are often large. In these situations, it is almost impossible to acquire the detailed conventional biometric information. Unlike other biometrics, gait can be captured from a distant camera, without drawing the attention of the observed subject [1].

In this paper, a new algorithm for human gait recognition is proposed, which is based on All Pairs Shortest Path distance. Four features points are selected by choosing definite number of coordinate points on the grayscale images (on all frame sequences) at some specific locations i.e. ankle, toe, knee and palm. Each coordinate point is considered to be a node and the weight between these nodes is calculated by Euclidean distance method. By using these weights of the nodes All pairs shortest path distance is calculate. Recognition is achieved by matching these shortest path distances.

2. Related Work

Xiaxi Huang et al. [1] consider the five viewing direction, combine all the viewing direction and find the similarity. Calculate and combine the optimal weight vector for all viewing direction which produce better recognition result against the single viewing direction. Wang and Liu [9] presented a simple and efficient gait recognition method based on positioning body joints. The coordinates of joints are computed according to the geometrical characteristics while walking. The limbs angles are computed based on the coordinates of joints and then made discrete Fourier transform. The amplitude-frequency and phase-frequency of angles are chosen as gait feature. At last the nearest neighbor classifier is used to classify subjects.

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Yanmei Chai Jinchang Ren et al.[3] proposed a statistical approach for dynamic gait signature extraction. The dynamic variance signal (DVS) on each of the pixel position for a full gait sequence is extracted firstly, and then compute their variance features respectively to construct a dynamic variance matrix as gait signature for identification. Imed Bouchrika et al.[7] carried out a research to confirm the early psychological theories claiming that the discriminative features for motion perception and people recognition are embedded in gait kinematics. Dynamic versus static features are reviewed and discussed with their potentials for people identification using gait. The gait angular measurements derived from the joint motions mainly the ankle, knee and hip angles, possess most of the discriminatory potency for gait recognition.

3. Proposed Algorithm.

In this paper, Proposed a new algorithm or method for recognizing gait system shown in fig1. This algorithm is based on All pair shortest path distance. The proposed gait recognition system consists of three units: image preprocessing, feature extraction, and gait recognition.

3.1. Image preprocessing.

In our experiments, there are two assumptions for the human walking sequences: (1) the camera is static and the body in the field of view is not occluded, (2) the image sequence of side-view is used. Each frame is converted into gray scale if it is a color image shown in fig 2(a) and 2(b).

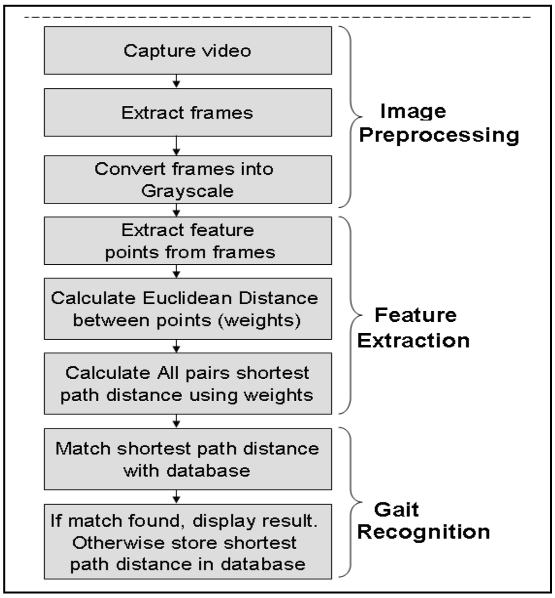

Fig. 1: Proposed Algorithm

Fig. 2: (a) Original Image [5]. (b) Corresponding Grayscale Image.

3.2. Gait feature selection.

Gait feature is further divided into three level: Key frame generation and Selection of feature Control points, weight between nodes of graph and shortest distance.

3.2.1 Key frame generation and selection of feature control points.

The key frames are the image of walking sequences, by observing the different phases of a human walk cycle as shown in Fig3. The first key is defined at the pose where front leg is standing straight while the backleg is bend and slight above the ground. The second key is at the location where the front leg's foot is flat on the ground and back leg's toe touches the ground. The third key is defined as the pose where the back leg's foot if flat on the ground and front leg's ankle touches the ground. The fourth key will return back to the first key and complete the cycle [2].

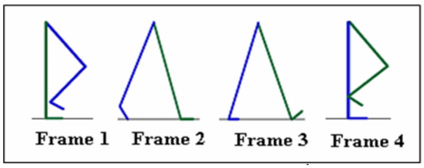

Fig.3.Key frames generation

Fig.4.sequence of feature selection

For feature selection using CASIA database, consider the only dynamic part of the body. Select four feature points from every frame of an image according to Fig.4. Here, Select first point is ankle, second is toe, third control point is knee; next selected point is palm.

3.2.2 Weight between the node of graph.

For feature selection using CASIA database, co The selected control points (x_i, y_i) is consider the node of the graph. Since four points are selected from one frame and there are four sequence frames, hence total nodes will be equal to sixteen. Every node of first frame has been connected to third frame, itself in first frame and third frame also. The same procedure is followed to the second frame and fourth frame. Weight between the two node has been calculated by Euclidean distance method. Euclidean distances between nodes are calculated in the following manner [4]:

$$d = \sqrt{(x_2 - x_1)^2 - (y_2 - y_1)^2} \qquad (1)$$

Where d is the weight between two nodes and represented by W. Weight vectors(w) is a combination of weights,W= {W114,W124,, ... }where W124 represent the 1^{st} frame of 4^{th} node is connected to 2^{nd} frame with 4^{th}node, in a similar way frames of nodes are connected to each other and form a graph shown in fig 5.

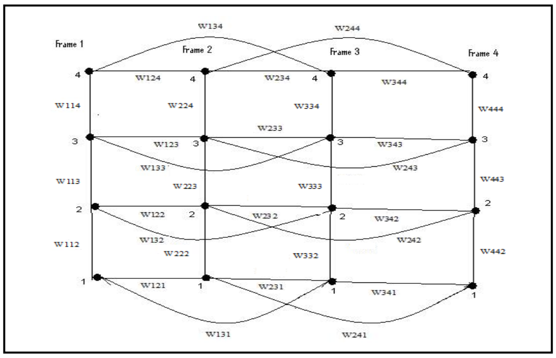

Fig.5.Corresponding Graph

```
Procedure All_Path(Cost, A,n)
Integer i, j, k, n; real Cost(n, n),A(n,n)
    for i: 1 to n do
    for j: 1 to n do
A(i, j)=Cost(i,j)
    repeat
repeat
for k:1 to n do
   for i: 1 to n do
    for j: 1 to n do
A(i,j)= min{A(i,j),A(i,k)+A(k,j)}
    repeat
repeat
    repeat
end
```

Fig.6. All pair shortest path distance algorithm.

3.2.3 Shortest Distance.

The selected feature control points i.e vertices (nodes) of the graph are obtained from the frames and edges represent the relations between nodes. First we calculate the weights between nodes using Euclidean distance and then finally calculate All pairs shortest path distance that will be used for recognition. These weights are assigned to the corresponding edges(connecting two nodes) of graph, All pairs shortest distance algorithm is calculated shown in fig.6.[10].The calculated shortest distance A(i,j) are stored in the database of every individual subject.

3.3. Gait recognition.

To find similarity between input shortest distance value and compare it with the database values by using nearest neighbor classifier by using Euclidean distance. If the value is matched with the database then recognition is successful otherwise stored in the database.

4. Experimental Result and Analysis.

The evaluation of our proposed all pair shortest path distance method for person identification, a gallery dataset of 80 video sequences are taken from the CASIA gait database [5]. Consider only side view and motion part of the body. The set consists of 20 different subjects with 4 sequences for every individual which complete one cycle. The results are obtained in Rank 1 and Rank 5. Rank 1 result shows that the test subjects or test set is identified exactly from the database. Rank 5 results shows that their actual match is in the top 5 matches from the reference database [1].

The results generated by the proposed method as shown in table1, table2 and table3. Twenty person or subject are represented by Id and their corresponding shortest distance shown in table 1. To test I/P image with the database, select any four frame which complete the human gait cycle. Use four feature control points in the following sequence from every frame, which is shown in Fig4. Here, first point is selected i.e. ankle, toe, knee, and palm. These feature control points are connected to another frame of feature control points. When 4 frames are connected by their feature control points. Then graph is formed shown in fig5 . The weight for edge of the graph calculated by Euclidean distance method between the feature control points.

Recognition is identified by using the Shortest distance. The identified the person represented alphabetically with their Shortest distance are given in table2 Randomly selected person of images are matched or not given in table 2, as per result of table 2, it is found that the recognition rate become 75% for rank1 and 95% for rank5, our method produce better recognition rate for rank5. It is observed from table3(randomly selected six person) that small variation are found in shortest distance value of test input image values and database values. The Shortest distance variation becomes due to taking control points manually.

4.1. Analysis.

Every person has unique style of walking and repeated motion of the body parts. When we use the shortest distance on the basis of experimental result it is found that every person has unique weighted graph and shortest distance. Shortest distance can not be same for other person because of repeated motion of the body part palm, knee, ankle and toe are moves up to the maximum length and angle. Euclidean distance between node is always same on taking another gait cycle. As per the analysis of table 3.The variation are found due to the slightly changed value of toe, knee and palm for the same person on selecting 4 frames. calculate the shortest distance values to recognize the person.

Table 1 Shortest Path Distance Database different inputs

Id	Shortest distance
1	124.7875
2	103.992
3	101.5417
4	108.5144
5	108.5587
6	93.0469
7	95.1235
8	109.5889
9	116.5584
10	82.884
11	97.1135
12	127.4534
13	99.1059
14	103.5436
15	104.17
16	95.9692
17	110.4586
18	105.6831
19	88.0074
20	95.0646

Table 2 Rank 1 and Rank 5 match results for 20

S. No	INPUT IMAGE	RANK 1 (Match found or not)	RANK 5 (Match found or not)
1.	A	YES	YES
2.	B	NO	NO
3.	C	YES	YES
4.	D	YES	YES
5.	E	YES	YES
6.	F	YES	YES
7.	G	NO	YES
8.	H	YES	YES
9.	I	YES	YES
10.	J	YES	YES
11.	K	NO	YES
12.	L	YES	YES
13.	M	YES	YES
14.	N	YES	YES
15.	O	YES	YES
16.	P	YES	YES
17.	Q	NO	YES
18.	R	YES	YES
19.	S	YES	YES
20.	T	NO	YES

5. Conclusion.

In this paper, we proposed a novel gait recognition method based on the shortest distance. First we select the points on sequence frames, calculate the weight of the edge by using Euclidean distance method and then draw the graph using these weight and finally calculate the shortest distance. These shortest values are used for person identification. The experiments results on real sequences have obtained the recognition rate 95% for rank5 and 75% for rank1 on CASIA database, respectively. Experimental results demonstrate that our proposed algorithm achieves better recognition rate.

6. Future Work.

This work can be enhanced using multiple views instead of a single view (i.e. side view used in the proposed work) and use some scaling factor value which equalized the control point when the same person walks sometimes near and sometimes far from the camera.

- Recognition is much higher than other methods.
- It does not require silhouette images and GEI images.
- Computational speed becomes high due to use of simple calculations like Euclidean distance.

Table 3. Matched Shortest distance Rank 1 and Rank 5.

S.D of input image	Matched S.D (Rank -1)	Matched S.D (Rank -5)
Input Image-1 S.D:123.2569	ID no.- 1, S.D- 124.7875	ID no.- 1,S.D - 124.7875 ID no.- 12,S.D - 127.4534 ID no.- 9,S.D - 116.5584 ID no.- 17,S.D - 110.4586 ID no.- 8,S.D - 109.5889
Input Image-2 S.D:102.8316	ID no.-14, S.D - 103.5436	ID no.-14,S.D -103.5436 ID no.-2,S.D -103.992 ID no.-3,S.D -101.5417 ID no.-15,S.D -104.17 ID no.-18,S.D -105.6831
Input Image-3 S.D:109.99	ID no.-8 S.D-109.5889	ID no.-8,S.D -109.5889 ID no.-17,S.D -110.4586 ID no.-5,S.D -108.5587 ID no.-4,S.D -108.5144 ID no.-18,S.D -105.6831
Input Image-4 S.D:-95.6585	ID no.-16 S.D-95.9692	ID no.-16,S.D -95.9692 ID no.-7,S.D -95.1235 ID no.-20,S.D -95.0646 ID no.-11,S.D -97.1135 ID no.-6, S.D -93.0469

Input Image-5 S.D:116.2111	ID no.-9 S.D-116.5584	ID no.-9,S.D -116.5584 ID no.-17,S.D -110.4586 ID no.-8,S.D -109.5889 ID no.-5,S.D -108.5587 ID no.-4,S.D -108.5144
Input Image-6 S.D:92.0378	ID no. -6 S.D-93.0469	ID no. -6,S.D-93.0469 ID no. -20,S.D- 95.0646 ID no -7, S.D- 95.1235 ID no -16,S.D- 95.9692 ID no – 19, S.D- 88.0074

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