Hindawi
Mobile Information Systems
Volume 2021, Article ID 1684726, 11 pages
https://doi.org/10.1155/2021/1684726

*Research Article*

# Accurate Recognition Method of Human Body Movement Blurred Image Gait Features Using Graph Neural Network

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Received 21 May 2021; Accepted 5 July 2021; Published 15 July 2021

Academic Editor: Sang-Bing Tsai



In view of the problems of low precision, poor quality, and long time of gait feature recognition due to the influence of human body movement environment on the recognition process of the current gait feature recognition method of human body movement blurred image, a new method of gait feature recognition based on graph neural network (GNN) method is proposed. The gait features of human movement blurred images were extracted, and the fusion clustering recognition of the GNN algorithm was used to locate the gait features of human movement blurred images. The gait features of human body movement blurred images were located by the GNN method. According to the contour feature point info of the human body movement blurred image, the standard deviation of gait feature location of the human body movement blurred image was calculated, the gait feature of the blurred image of human body movement was reconstructed, and the gait recognition of the human body movement blurred image was achieved. The results show that the extraction of human movement is good, with high positioning confidence, good recognition quality, average recognition accuracy of 92%, and greatly shortened recognition time.

## 1. Introduction

Gait feature recognition is an emerging biometric recognition technology in recent years. It is a new combination of human body movement blurred image and biometric authentication technology, and it is also a research direction that has attracted more attention in the field of biometrics. As gait feature recognition has the advantages of long distance and being not easy to camouflage, it is suitable for intelligent video surveillance on safety and sensitive occasions [1]. Therefore, gait feature recognition has become a key research topic of scientific research institutions in various countries. Although gait feature recognition has advantages over some technologies such as image recognition [2], it also has obvious disadvantages. Although there are many software algorithms for gait feature recognition, most original intentions are exploration rather than professional system development [3]. Therefore, it is still an important and arduous challenge to accurately recognize the gait features of human body movement blurred images.

In recent years, with the rise of deep learning, neural network has become the mainstream technology of image analysis. With the gradual in-depth analysis of deep learning in image application, combined with convolution network, cyclic network and depth automatic encoder, and other related technologies, graph neural network (GNN), a new deep learning method, has emerged, which can deeply reveal the layer information. Compared with the traditional neural network, GNN can directly take the image as the input, has a certain reasoning ability, has a significant advantage in the field of machine vision, has a certain advantage, and is widely used in image analysis.

At present, there are many related research results on GNN. Literature [1] has pointed out that GNN, a deep learning method, shows the results of structure attribute relationship prediction. GNN uses a backpropagation algorithm to learn physicochemical properties as functions of a molecular graph in supervised learning settings. This end-to-end learning method eliminates the need to select molecular descriptors or structure groups because it learns the best fingerprint by graph convolution and maps the

fingerprint to physical and chemical properties by deep learning; this article uses graph convolution to obtain better analysis results. In literature [2], a block-based deep learning algorithm of GNN has been proposed. The algorithm can be understood as a representation learning process to extract useful interactions between target atoms and their neighboring atomic groups. The results show that GNNhas universal applicability. In literature [3], random edge GNNis introduced to convolute the random graph formed by fading interference mode in a wireless network. Through numerical simulation, it is proved that GNN has strong transferability.

In response to the above problems, a method for accurately identifying gait features of human body movement blurred images based on the GNN method is proposed. In this article, the GNN method is applied to recognize gait features in human body movement blurred images accurately. The aspects of recognition accuracy, quality, and recognition time improve the ability of accurate recognition of gait features in human body movement blurred images.

(1) According to the distribution probability density of the human body movement blurred image, the gray-scale pixel set of the human body movement blurred image is extracted. The fusion clustering recognition of the GNN method is used to locate the gait features of the blurred human body movement image and accurately recognize the gait features of the blurred human body movement image, thereby improving the accuracy of gait feature recognition.

(2) By calculating the edge contour amplitude of the gait feature of the human body movement blurred image, the contour feature point information of the human body movement blurred image is obtained. This solves the quality problem of the human body movement blurred image in the acquisition process, avoids the garbled and distortion of the gait feature info of the human body movement blurred image, which causes poor image quality, and effectively guarantees the quality of the gait feature of the human body movement blurred image.

(3) Combining the standard deviation of the gait feature of the human body movement blurred image during positioning, the gait feature of human body movement blurred image is reconstructed, which effectively shortens the gait feature recognition time.

## 2. Related Work

In recent years, domestic and foreign academic circles have carried out a lot of research on gait feature recognition. Literature [4] has proposed a gait motion recognition method based on inertial sensors and AdaBoost algorithm and set the signal as the motion sample. The positioning compensation matching algorithm is used to correct the sensor tilt, and the AdaBoost algorithm is used to adaptively select the movement features and discriminate and analyze the movement features to realize the gait movement recognition. This method has a high recognition accuracy but low recognition efficiency. Literature [5] has proposed an interpretable gait recognition method based on time series features, set a multidimensional time series as gait features, and adopted the most discriminative subsequence shapelet classification method in the time series to identify interpretable gait. This method can provide better interpretability and improve recognition efficiency, but it has the problem of low recognition accuracy. Literature [6] hasproposed a restricted Boltzmann machine gait feature extraction and recognition method. According to the pedestrian image sequence, the background segmentation is used to calculate the gait period, and the superposition method is used to generate the gait energy map as the feature image, and the restricted Boltzmann machine is used to obtain the gait feature and realize the gait feature recognition. This method has high recognition performance, but the recognition time of this method is longer. Literature [7] has proposed a human gait recognition method based on a time series data sequence of joint angles. According to the human body movement capture device, the joint angle time series data sequence is obtained. The radial basis function is used to construct the internal dynamics model of human gait, and the gait dynamics are obtained by neural network (NN) approximation for storage, express the features of human moving gait, and realize gait recognition based on the definition of similarity. This method can accurately identify gait features, but there is a problem of low recognition efficiency. Literature [8] has proposed a robust gait recognition method for different carried items, by estimating the gait template of uncarried items, mixing it with the original template using the mixing parameters, and creating a mixed parameter hybrid template from the original template and the uncarrying item template generated based on the estimated mixing parameters. Two independent generators are used to estimate the mixed parameters and the generation template of uncarried items, and the mixed parameter mixed gait template is input into the recognition network for gait recognition. The recognition efficiency of this method is high, but the recognition quality is poor. Literature [9] has proposed a gait recognition system independent of direction that recognizes objects through gait, adopts signal processing technology to eliminate the difference between the induced signals caused by walking in different directions, and generates high-quality direction-independent signal spectrograms, thereby manually or automatically extracting effective features from the direction-independent spectrograms. The recognition accuracy of this method is high, but the recognition quality is poor. Literature [10] has proposed a multiviewpoint gait recognition method based on spider web GNN. The single-viewpoint gait data is connected with other viewpoint gait data at the same time to construct an active graph convolutional neural network. Through the combination of the storage module and the capsule module, the gait trajectory of each viewpoint is analyzed, and multiviewpoint feature fusion and single-viewpoint spatiotemporal feature extraction are realized. The gait recognition quality of this method is high, but the recognition accuracy is low.

In view of the above problems, this article introduces the GNN algorithm to recognize gait features of human

body movement blurred image in order to obtain a more accurate recognition effect. The biggest difference with other methods is that this article calculates the standard deviation of the extracted contour feature points and reconstructs the gait features according to the standard deviation, which effectively improves the accuracy of gait feature recognition. The experimental results show that the average recognition accuracy of the proposed method is as high as 92%, and the maximum recognition time is only 15.1 s.

## 3. Design of Accurate Recognition Method for Gait Feature of Blurred Human Body Movement Image

*3.1. Gait Feature Extraction of Human Body Movement Blurred Image.* Before locating the gait feature of the blurred human body movement image, $p^*$ is used to represent the dynamic constraint boundary point of the gait feature positioning of the blurred human body movement image. $\theta^*$ refers to geometric constraints of gait feature location in blurred human body movement images. All gait features are placed in space coordinate system to get the gait feature dataset of the human body movement blurred image. It is shown in the following formula:

$$(\theta^e, \rho^e) = \mathrm{EFA}(\theta^*, \rho^*), \tag{1}$$

where $\rho^e$ refers to the dynamic constraint boundary points of gait feature data and $\theta^e$ refers to geometric constraints. EFA is the factor analysis function.

In the gait feature location, the edge pixel set of the human body motion blurred image is $h$. Introduce the method of three-dimensional dynamic area planning and use $\lambda$ as the quantitative center of gait feature positioning. According to the distribution probability density of the human body movement blurred image, the gait feature quantity is merged, and the gray pixel set of the human body movement blurred image under the dynamic constraint of the gait feature positioning is extracted, as shown in the following formula:

$$\sigma(Z, D_X) = \sum_{i>j} \frac{\left|d_{ij}(Z) - d_X(x_i, x_j)\right|^2}{\lambda h}, \tag{2}$$

where $d_{ij}(Z)$ refers to the Euclidean distance and $d_X(x_i, x_j)$ refers to the spatial distribution distance of gait features of human body movement blurred image in the spatial coordinate system. The fusion clustering recognition of the GNN method is used to locate the gait features of the blurred human body movement image, as shown in the following formula:

$$G_{m,n} = \begin{pmatrix} g_{(m,n)}(1,1) & g_{(m,n)}(1,2) \\ g_{(m,n)}(2,1) & g_{(m,n)}(2,2) \end{pmatrix}, \tag{3}$$

where $g_{(m,n)}(u, v) = I_{(k)g}[2(m-1)+u, 2(n-1)+v]$ and $u$and $v$ refer to the GNN operator for gait feature location in human body movement blurred image.

Based on formula (3), the gray-scale quantization method [11] is used to adaptively learn the gait features of the human body movement blurred image and locate the gait features of the human body movement blurred image. The specific implementation model is shown in Figure 1.

All gait features are placed in space coordinate system to get the gait feature dataset of the blurred human body movement image. According to the distribution probability density of the blurred human body movement image, the gray-scale pixel set of blurred human body movement image is extracted. The fusion clustering recognition of the GNN method is used to locate the gait features of the blurred human body movement image.

*3.2. Gait Feature Localization Based on GNN Algorithm.* Based on the gray pixel set of gait features extracted from human body movement blurred images, the gait features of human body movement blurred images are located using the fusion clustering recognition of the GNN algorithm. GNN algorithm is a kind of neural network based on graph convolution. A convolution module is added to the network. Each part of the image is regarded as a graph node, and the node relationship graph is constructed to avoid ignoring the occluded part of the image and it can effectively locate the gait features of human body movement blurred images. The structure of the gait feature localization network of GNN motion blurred image is shown in Figure 2.

According to Figure 2, firstly input the feature data extracted in Section 3.1, and call this feature a shallow feature. After using graph convolution neural network (GCN) fusion clustering recognition, the occluded part of the feature is integrated to obtain the image internal structure information. Using the loss function to train the model, deep analysis of human body movement blurred image gait features, the feature location is completed.

*3.3. Reconstruction of Gait Features in Blurred Human Body Movement Images.* This article uses the blurred image gait feature segmentation method to segment and reconstruct the human body movement gait feature and complete the design of the blurred human body movement image gait feature recognition method. In addition, this article proposes an accurate recognition method for gait features of human body movement blurred images based on gait database and low-dimensional gait vectors and calculates the edge contour amplitude $N_l$ of the gait features of human body movement blurred images using the tilt angle sequence diagram [12], as shown in the following formula:

$$N_l = \begin{cases} 1, & l = 0, L, \\ \left[2\pi \cdot \dfrac{D}{2} \cdot \dfrac{\sin\eta}{l_{\mathrm{triangle}}}\right], & l = 1, \ldots, L-1, \end{cases} \tag{4}$$

where $l_{\mathrm{triangle}} = \pi \cdot D/2L$ refers to the pixel values of blurred images in the human body movement area and $L$ refers to the gray difference value of the gait feature of the blurred human body movement image in the pixel distribution area.

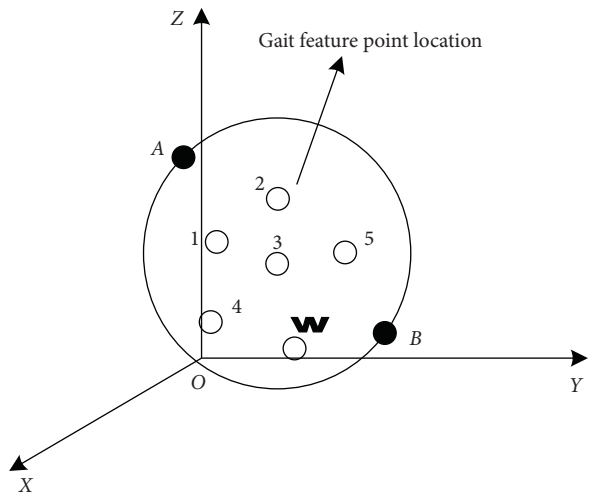


Figure 1: Gait feature location model of human body movement blurred image.

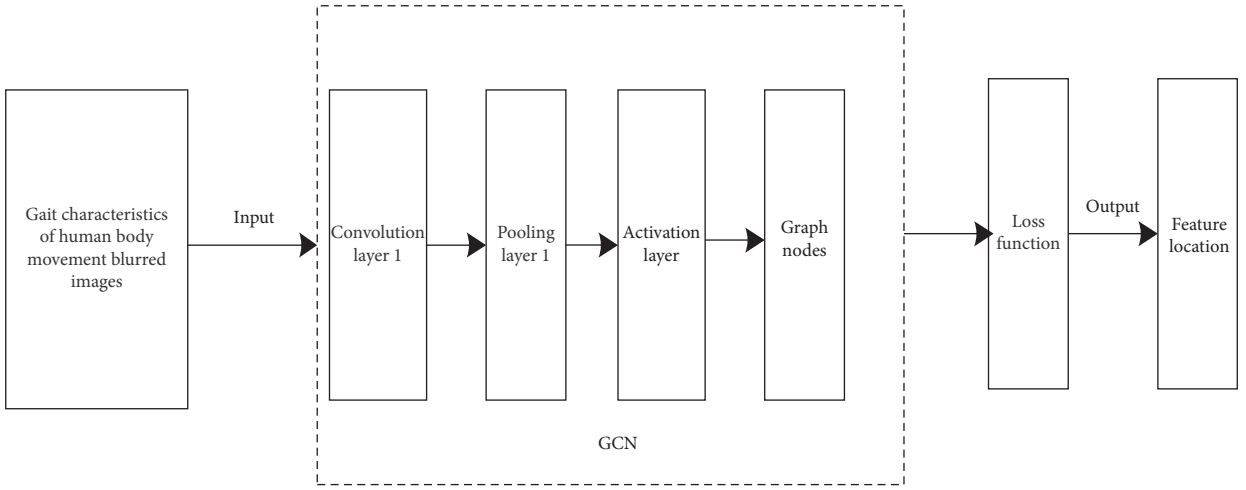


Figure 2: Gait feature localization network structure of GNN human body movement blurred image.

$D$ is the gray difference value of gait feature in pixel distribution area of human body movement blurred image. The formula describes the block contour feature amount of the human body movement blurred image $Q(x_i, y_i)$. When $i = 1$, read the block contour feature point info of the blurred human body movement image [2], as shown in the following formula:

$$x_i(t) = \sum_{k=1}^{p} \sum_{l=0}^{2} \varphi_{kl} Q(x_i, y_i), \tag{5}$$

where $x_i(t)$ refers to the reading result of block contour feature point information of blurred human body movement image, $\varphi_{kl}$ refers to phase shift during gait feature tracking, and $Q(x_i, y_i)$ refers to blurred human body movement image. If there are $N$ gait feature points in the human body movement blurred image read, the standard deviation of the gait feature of the human body movement blurred image during positioning can be calculated, as shown in the following formula:

$$\mathrm{STD}(X, Y) = \frac{2\left|\sum_{i=1}^{N} c_x c_y\right| + I(m, n)}{\sum_{i=1}^{N} |c_x|^2 + \sum_{i=1}^{N} |c_y|^2 + \overline{I}}, \tag{6}$$

where $c_x$ refers to the center position of the gait feature of the blurred human body movement image and $c_y$ refers to the gray extreme value of gait features in blurred human body movement images. $I(m, n)$ refers to the extraction result of the gait feature of the blurred image of the human body during the positioning process of the dynamic constraint feature quantity [13]. Based on $\overline{I}$, the gray-scale histogram pixel set is constructed, and the gait features of the human body movement blurred image are reconstructed, and the pixel value $\overline{I}$ is reconstructed, as shown in the following formula:

$$\overline{I} = \frac{1}{N}\sum_{i=1}^{N}\sum_{j=1}^{N} I(m,n). \tag{7}$$

The center pixel of the gait feature of the obtained human body movement blurred image satisfies $\varphi = \theta$. If $\lambda = \sigma/\beta$ refers to the sample sequence set. $F = \sqrt{U^2 + V^2}$ refers to spherical harmonic function. The segmentation and recombination quantitative tracking method is used for feature tracking and identification [14], and the geometric invariant moments obtained are as follows:

$$\begin{cases} \mathrm{EX}^{(\mathrm{cs2})} = \{x | x \in [0,h], \\ \mathrm{EY}^{(\mathrm{cs2})} = \rho^e \cos\theta^e, \\ \mathrm{EZ}^{(\mathrm{cs2})} = \rho^e \sin\theta^e, \end{cases} \tag{8}$$

where $\mathrm{EX}^{(\mathrm{cs2})}$ refers to the geometric invariant moments in the $X$-axis direction, $\mathrm{EY}^{(\mathrm{cs2})}$ refers to the geometric invariant moments in the $Y$-axis direction, $\mathrm{EZ}^{(\mathrm{cs2})}$ refers to the geometric invariant moments in the $Z$-axis direction, $\rho^e$ refers to the dynamic constraint boundary points of gait feature data, $\theta^e$ refers to the geometric constraints, and $h$ refers to the height.

The feature segmentation method [15, 16] is used to reconstruct the gait feature location feature points of the human body movement image, and the gray-scale histogram pixel set under the gait feature location of the human body movement blurred image is extracted. Take $\rho^e - R$ as the rotation output invariant moment to perform the spatial translation in the $x$-axis direction, so as to realize the reconstruction of the gait feature of the human body movement blurred image [17].

By calculating the edge contour amplitude of the gait feature of the human body movement blurred image, the block contour feature point info of the human body movement blurred image is read. Combining with the standard deviation of the gait features of the human body movement blurred image during positioning, the gait features of the human body movement blurred image are reconstructed [18, 19].

## 4. Construction of a Blurred Recognition Method for Gait Features of Human Body Movement Images

Input: when constructing the algorithm for gait feature recognition of human body movement blurred images, it is necessary to preprocess the gait features of human body movement blurred images. The main steps include background modeling, segmentation, binarization processing, and morphological denoising processing of blurred human body movement images.

Output: the gait feature of the blurred human body movement image.

(1) The background modeling of the human body movement blurred image is to segment the foreground image and the background image of the gait feature to track the motion form of the human body. The GNN method is used to establish the background model of the human body movement $\{I_i(x,y)\}$. $(x,y)$ refers to pixel coordinates of blurred human body movement images, $i$ refers to ordinal number of blurred human body movement image frames, and $N$ refers to the total number of frames of the blurred human body movement image sequence; then, the frame difference of the human body movement blurred image can be described as follows:

$$\mathrm{CDM}_i(x,y) = \begin{cases} d, & d \geq T, \\ 0, & d < T. \end{cases} \tag{9}$$

(2) After extracting the background of the blurred human body movement image, it is necessary to segment the gait feature of the blurred human body movement image from the extracted background because the difference method is difficult to ensure the accuracy of the segmentation of the blurred human body movement image gait feature. Therefore, the GNN method is used to segment the gait features of the human body movement blurred image as shown in the following formula:

$$\begin{cases} F(I,B) = 1 - \dfrac{2\times\sqrt{(I+1)\times(B+1)}}{(I+1)\times(B+1)} \times \dfrac{2\times\sqrt{(256-I)\times(256-B)}}{(256-I)+(256-B)}, \\ 0 < f(I,B) < 1, 0 < I(x,y) < 255, \quad 0 < B(x,y) < 255, \end{cases} \tag{10}$$

where $B$ refers to the pixel value of blurred human body movement image at the point $(x,y)$ and $I$refers to the pixel value of blurred human body movement image at the current framework $(x,y)$. If $B$ equals $I$, the value of $F(I,B)$ is 0.

(3) The binarization processing method is used to process the segmented blurred human body movement image, and the relatively small noise area in the blurred human body movement image is eliminated. The process of binarization of the blurred human body movement image is shown in the following formula:

$$M_{x,y} = \begin{cases} 1, & f\left(I_{xy}, B_{xy}\right) \geq T, \\ 0, & \text{otherwise}. \end{cases} \tag{11}$$

After removing the background of the blurred human body movement image and the binarization process, in order to avoid noise and small holes affecting the gait feature recognition effect of the blurred human body movement image, the GNN method is used to filter the noise of the human body movement blurred image, and the small holes in the blurred image are filled. The blurred human body movement image after morphological denoising processing still has noise. In order to eliminate the influence of objective factors on gait feature recognition, the blurred human body movement image is normalized.

(4) Spatial features are described as the spatial features of the normalized human body movement blurred image in the polar coordinate system, and a point is selected on the cutting line. If the point $(\rho, \theta)$ is in the human body movement area, the value of the cutting function is 1; otherwise, it is 0. The function expression is as follows:

$$f_\rho(\theta) = \begin{cases} 1, & (\rho, \theta) \text{ In human motion.} \\ 0, & (\rho, \theta) \text{ Outside human motion.} \end{cases} \tag{12}$$

Assuming that there are $m$ cutting lines, and each cutting line has $n$ points, the gait feature matrix of the blurred human body movement image is established as follows:

$$F = \begin{bmatrix} f_{p_1,0} & f_{p_1,1} & f_{p_1,2} & \cdots & f_{p_1,(N-1)} \\ f_{p_2,0} & f_{p_2,1} & f_{p_2,2} & \cdots & f_{p_2,(N-1)} \\ \cdots & \cdots & \cdots & \cdots & \cdots \\ f_{p_n,0} & f_{p_n,1} & f_{p_n,2} & \cdots & f_{p_n,(N-1)} \end{bmatrix}. \tag{13}$$

(5) Because everyone's gait features are very different, the recognition accuracy is poor. The frequency feature can be used to supplement the gait feature of the human body movement blurred image, and the frequency feature of the human body movement blurred image can be extracted, as shown in the following formula:

$$V(\rho, k) = \sum_{j=0}^{N-1} f_\rho(\theta_j) \exp\left(-\frac{i2\pi k j}{N}\right), \tag{14}$$

where $k$ refers to frequency and $f_\rho(\theta_j)$ refers to the upper point of cutting vector.

(6) The gait features of the human body movement blurred image are arranged in ascending order according to the frequency, and the gait features of the human body movement blurred image at the same frequency are obtained. At the same frequency, the gait features of the human body movement blurred image are recognized as shown in the following formula:

$$V_k = \frac{V(\rho, k) v_{p_{mk}}}{f_\rho(\theta_j)}. \tag{15}$$

(7) End

In summary, the GNN method is used to establish the background model of the human body movement blurred image. The background of the human body movement blurred image is extracted. Based on the normalization and binarization of the human body movement blurred image, the frequency features of the human body movement blurred image are extracted, and the accurate recognition of the gait features of the human body movement blurred image is realized, as shown in Figure 3.

## 5. Experimental Analysis and Results

*5.1. Experimental Environment and Dataset.* In order to verify the validity of the accurate recognition method of human body movement blurred image gait features based on the GNN method, experiments were carried out in Matlab2008 environment, gait feature data were collected through CMOS, and UCSD dataset, MIT gait dataset, and Soton dataset were selected as the experimental data.

A total of 6 people are included in the UCSD data set, and each person has 7 gait sequences. The camera is fixed on a tripod to collect pedestrian gait characteristic data.

The MIT gait dataset is gait characteristic data collected on four different dates in two months under different indoor environments. It includes a total of 24 pedestrians and 194 sequences.

The Soton dataset contains a small dataset of 12 people and a large dataset of 115 people. The small dataset is collected under a green indoor background and mainly includes changes in detail, such as shoes and clothing when people are walking. The large dataset mainly includes the physiological condition of the person, which is more convincing for the test of gait feature recognition.

*5.2. Experimental Indicators*

(1) Gait feature recognition accuracy: It refers to the correct degree of recognition of the gait feature of the blurred human body movement image. It is used to reflect the accuracy of gait feature recognition in blurred human body movement images. The higher the accuracy of gait feature recognition, the higher the accuracy of gait feature recognition in blurred human body movement images. The calculation formula for the accuracy of gait feature recognition is as follows:

$$B_z = \frac{\alpha_z}{\chi_d} \times 100\%, \tag{16}$$

where $\lambda_z$ refers to the number of gait features needed to identify blurred human body movement images correctly and $\gamma_d$ refers to the total number of gait features in blurred human body movement images to be recognized.

(2) Gait feature recognition signal-to-noise ratio (SNR): It is the ratio of signal power to noise power, used to reflect the recognition quality of gait features in human

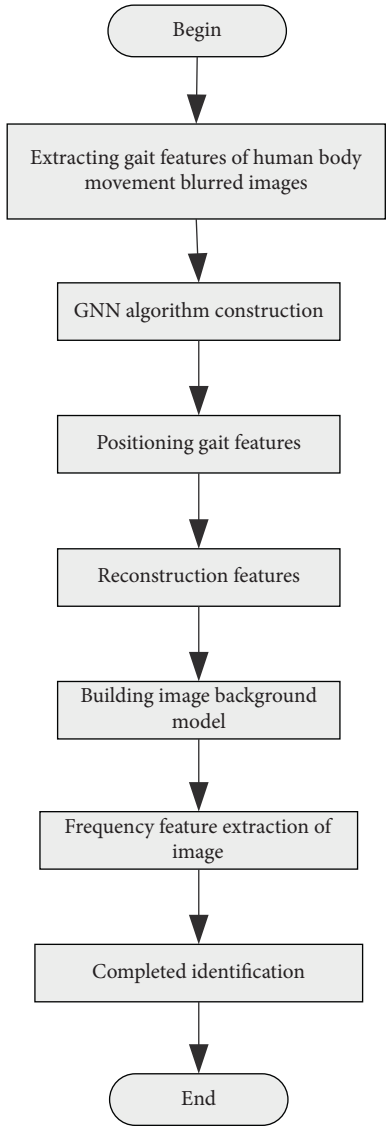


Figure 3: Accurate recognition process of gait features in human body movement blurred images.

body movement blurred images. The larger the SNR value of gait feature recognition, the better the quality of gait feature recognition in blurred human body movement images as shown in the following formula:

$$\mathrm{SNR} = \frac{P_s}{P_n} = \left(\frac{A_s}{A_n}\right)^2, \tag{17}$$

where $P_s$ refers to signal rate, $P_n$ refers to noise rate, $A_s$ refers to signal amplitude, and $A_n$ refers to noise amplitude.

(3) Gait feature recognition time: Taking the gait feature recognition time as an indicator, compare the proposed method with the method in the literature to verify the performance of the proposed method.

(4) Effect of human gait feature extraction: Select the original image of a specific image, according to different algorithms for image feature extraction, the formation of feature extraction map and comparison.

## 6. Results and Discussion

In order to verify the accuracy of the gait feature recognition method of the human body movement blurred image based on the GNN method, the methods in [4], [5], [6], [7], and [8] are used as comparison methods to perform test analysis to verify the recognition accuracy, recognition quality, and recognition time of different methods. The comparison results of gait feature recognition accuracy of human body movement blurred images with different methods are shown in Figure 4.

According to Figure 4, when the number of iterations is 500, the average human body movement blurred image gait feature recognition accuracy rate in [4] is 78% and in [5] is 59%. The gait feature recognition accuracy of the average human body movement blurred image in [6] is 83%; the average gait feature recognition accuracy rate in [7] of the blurred human body movement image is 72%. In [8], the-average human body movement blurred image gait feature recognition accuracy rate is 61%; and the proposed method's average human body movement blurred image gait feature recognition accuracy is 92%. It can be seen that the gait feature recognition accuracy of the human body movement blurred image of the proposed method is relatively high. Because the proposed method uses the fusion clustering recognition of the GNN method to locate the gait features of the blurred human body movement image, the recognition accuracy of the method is improved. The comparison results of gait feature recognition quality of human body movement blurred images with different methods are shown in Figure 5.

According to Figure 5, when the gait feature information of the human body movement blurred image is 500 MB and the number of iterations is 500 times, the maximum SNR in [4] is 25 dB. The maximum SNR in [5] is 29 dB, in [6] is 23 dB, in [7] is 20 dB, and in [8] is 20 dB. The noise ratio is 16 dB, and the maximum SNR of the proposed method is 36 dB. It can be seen that the SNR of the proposed method is larger, and the recognition quality is better, which can effectively ensure the quality of the gait features of the human body movement blurred image. This can avoid the problem of garbled characters and distortion in the gait feature information of the blurred human body movement image and improve the recognition performance of the gait feature of the blurred human body movement image. On this basis, the recognition time of the proposed method is further verified, and the comparison results of the recognition time of the gait feature of human body movement blurred images of different methods are further verified. It is shown in Table 1.

According to Table 1, with the increase of the gait feature info of the blurred human body movement image, the recognition time of the gait feature of the blurred human body movement image of different methods increases. When the feature information is 500 MB, the gait feature recognition time of the human body movement blurred image of

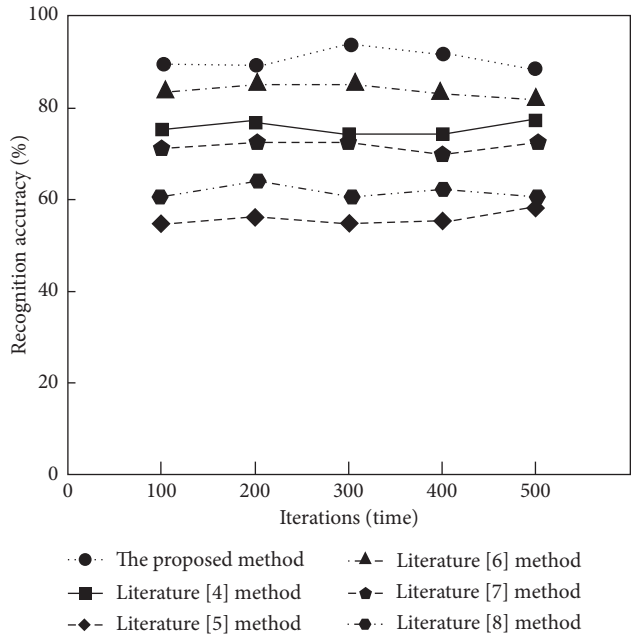


Figure 4: Comparison results of gait feature recognition accuracy of human body movement blurred images with different methods.

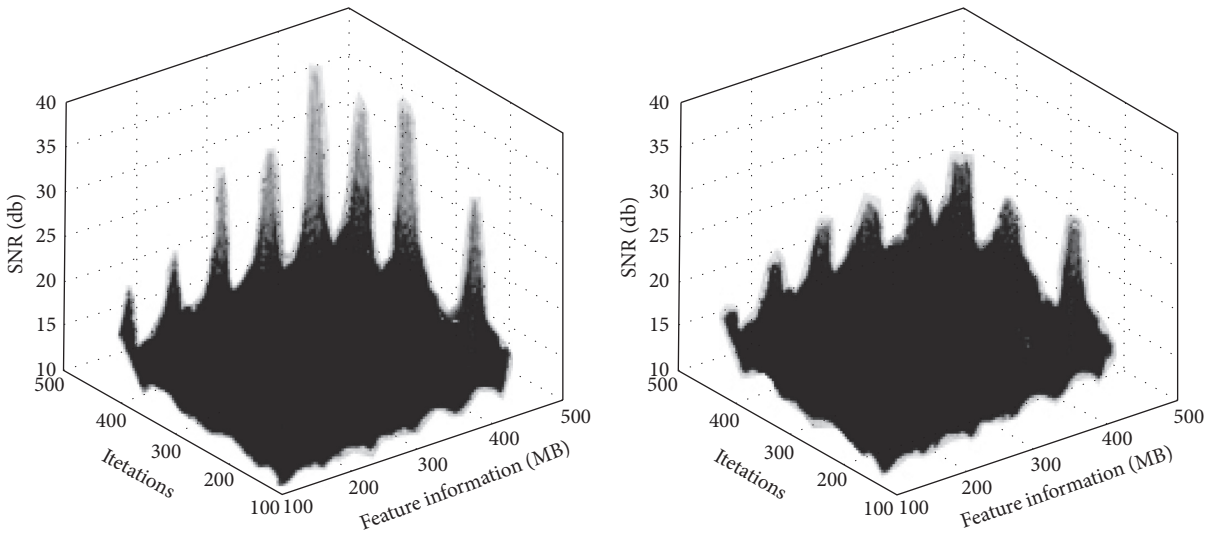


Figure 5: Continued.

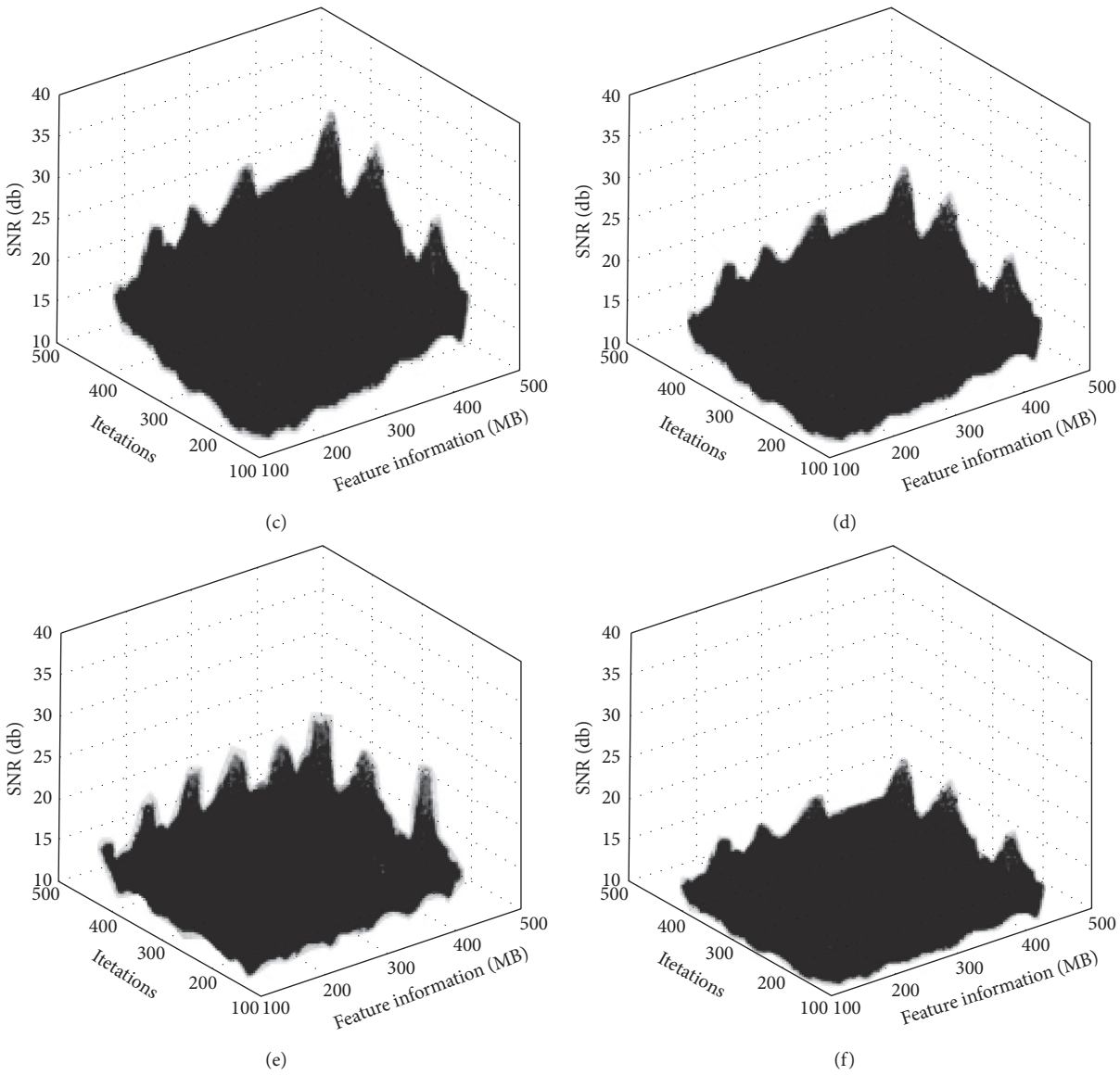


Figure 5: Comparison results of gait feature recognition quality of human body movement blurred images with different methods. (a) The proposed method. The methods from the literature in (b) [4]; (c) [5]; (d) [6]; (e) [7]; (f) [8].

Table 1: Comparison results of gait feature recognition time of human body movement blurred images by different methods.

| Feature information (MB) | Recognition time (S) | | | | | |
|---|---|---|---|---|---|---|
| | The proposed method | Method in [4] | Method in [5] | Method in [6] | Method in [7] | Method in [8] |
| 100 | 10.2 | 20.5 | 14.6 | 21.9 | 22.6 | 13.6 |
| 200 | 11.6 | 21.9 | 15.8 | 22.8 | 23.5 | 14.8 |
| 300 | 12.8 | 23.2 | 16.3 | 23.4 | 24.8 | 15.2 |
| 400 | 13.9 | 24.6 | 16.7 | 24.9 | 25.3 | 16.9 |
| 500 | 15.1 | 25.8 | 18.4 | 25.6 | 26.7 | 17.7 |

the method in [4] is 25.8 s; the gait feature recognition time of the human body movement blurred image of the method in [5] is 18.4 s; in [6] is 25.6 s; in [7] is 26.7 s; in [8] is 17.7 s, while the gait feature recognition time of the proposed method is only 15.1 s. It can be seen that the gait feature recognition time of the human body movement blur image of the proposed method is shorter. Because the proposed method reads the contour feature point information of the blurred human body movement image, combined with the standard deviation of the gait feature of the blurred human

Figure 6: Original image of human body movement.

(a) (b) (c) (d) (e) (f)

Figure 7: Gait feature extraction effect of human body movement image with different methods. (a) The proposed method.The methods in (b) [4]; (c) [5]; (d) [6]; (e) [7]; (f) [8].

body movement image during positioning, the gait feature of the blurred human body movement image is reconstructed, thereby shortening the recognition time.

Select the original human body movement image, as shown in Figure 6. According to Figure 6, this article compares the proposed method with the methods in [4], [5], [6], [7], and [8]. The results of human gait feature extraction of different methods are shown in Figure 7.

According to Figure 7, in this article, the effect of gait feature extraction of human body movement image is analyzed, and the gait of the original image can be extracted completely. Other works of literature can obtain the gait image more completely, but there is a fuzzy phenomenon in some parts of the human body. Therefore, the extraction effect is worse than that of the proposed method, which shows that the effect of gait feature extraction in this article is better.

## 7. Conclusions

This article proposes a method for precise recognition of gait features in human body movement blurred images based on the GNN method. According to the distribution probability density of the human body movement blurred image, the gray pixel set of the human body movement blurred image is extracted, and the fusion clustering recognition of the GNN method is used to locate the gait feature of the human body movement blurred image. Calculate the edge contour amplitude of the gait feature of the human body movement blurred image and obtain the contour feature point information of the human body movement blurred image. Combined with the standard deviation of the gait feature positioning of the blurred human body movement image, the gait feature of the blurred human body movement image is reconstructed, and the gait feature recognition method of the blurred human body movement image is designed to realize the feature recognition of the gait of the blurred human body movement image. The results show that the recognition accuracy of this recognition method is high, the recognition quality is better, and the recognition time can be effectively shortened. Although the method has high recognition performance, there are still many shortcomings in its specific application in practice. In future research, it is necessary to increase the part of example verification to improve the feasibility and practicability of the method.

## Data Availability

The data used to support the findings of this study are included within the article. Readers can access the data supporting the conclusions of the study from UCSD dataset, MIT gait dataset, and Soton dataset.

## Conflicts of Interest

The author declares that there are no conflicts of interest with any financial organizations regarding the material reported in this manuscript.

## Acknowledgments

This work was supported by National Natural Science Foundation of China (61774107).

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