HUMAN AUTHENTICATION WITH GAIT RECOGNITION

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ABSTRACT_ Human authentication is a critical aspect of security systems, and traditional methods often rely on passwords or biometric features such as fingerprints and facial recognition. This study explores a novel approach to human authentication using gait recognition, focusing on an individual's unique walking style. Gait recognition offers a non-intrusive and natural way to identify individuals, particularly in scenarios where traditional methods may be impractical.

The proposed system employs computer vision techniques to extract key features from video sequences capturing an individual's gait. Silhouette-based or skeleton-based representations are utilized to create a distinctive gait signature. Deep learning models, such as Convolutional Neural Networks (CNNs) and recurrent neural networks (RNNs), are then employed to learn and recognize the intricate patterns inherent in an individual's walking style. A comprehensive dataset comprising diverse walking conditions, attire, and speeds is used for model training and evaluation. The system is tested for its robustness against environmental variations and potential spoofing attempts.

The experimental results demonstrate the feasibility and effectiveness of gait recognition as a reliable method for human authentication. The proposed approach provides an additional layer of security that is difficult to replicate or forge, as an individual's gait is a subtle and unique biometric trait. The non-intrusive nature of gait recognition makes it suitable for applications in surveillance, access control, and secure authentication systems. Considerations for real-world deployment, including ethical considerations and user acceptance, are discussed. This research contributes to the evolving landscape of biometric authentication by introducing gait recognition as a viable and secure system with a valuable and efficient way to overcome the issue of security and authentication.

1.INTRODUCTION

GAIT refers to the style of walking of an individual. Often, in surveillance applications, it is difficult to get face or iris information at the resolution required for recognition. Studies in psychophysics indicate that humans have the capability of recognizing people from even impoverished displays of gait, indicating the presence of identity information in gait. From early medical studies, it appears that there are 24 different components to human gait, and that, if all the measurements are considered, gait is unique. It is interesting, therefore, to study the utility of gait as a biometric. A gait cycle corresponds to one complete cycle from rest (standing) position to-right-foot-forward-to-rest-to-left-foot forward- to-rest position. The movements within a cycle consist of the motion of the different parts of the body such as head, hands, legs, etc. The characteristics of an individual are reflected not only in the dynamics and periodicity of a gait cycle but also in the height and width of that individual. Given the video of an unknown individual, we wish to use gait as a cue to find who among the individuals in the database the person is. For a normal walk, gait sequences are repetitive and exhibit nearly periodic behavior. As gait databases continue to grow in size, it is conceivable that identifying a person only by gait may be difficult. However, gait can still serve as a useful filtering tool that allows us to narrow the search down to a considerably smaller set of potential candidates. Approaches in computer vision to the gait recognition problem can be broadly classified as being either model-based or model-free. Both methodologies follow the general framework of feature extraction, feature correspondence and high-level processing. The major difference is with regard to feature correspondence between two consecutive frames. Methods which assume a priori models match the two-dimensional (2-D) image sequences to the model data. Feature correspondence is automatically achieved once matching between the images and the model data is established. Examples of this approach include the work of Lee *et al.*, where several ellipses are fitted to different parts of the binarized silhouette of the person and the parameters of these ellipses such as location of its centroid, eccentricity, etc. are used as a feature to represent the gait of a person. Recognition is achieved by template matching. In Cunado *et al.* extract a gait signature by fitting the movement of the thighs to an articulated pendulum-like motion model. The idea is somewhat similar to an early work by Murray who modeled the hip rotation angle as a simple pendulum, the motion of which was approximately described by simple harmonic motion. In activity specific static parameters are extracted for gait recognition. Model-free methods establish correspondence between successive frames based upon the prediction or estimation of features related to position, velocity, shape, texture, and color. Alternatively, they assume some implicit notion of what is being observed. Examples of this approach include the work of Huang *et al.*, who use optical flow to derive a motion image sequence for a walk cycle.

Principal components analysis is then applied to the binarized silhouette to derive what are called eigen gaits. Benabdelkader *et al.* use image self-similarity plots as a gait feature. Little and Boyd extract frequency and phase features from moments of the motion image derived from optical flow and use template matching to recognize different people by their gait. A careful analysis of gait would reveal that it has two important components. The first is a structural component that captures the physical build of a person, e.g., body dimensions, length of limbs, etc. The second component is the motion dynamics of the body during a gait cycle. Our effort in this paper is directed toward deriving and fusing information from these two components. We propose a systematic approach to gait recognition by building representations for the structural and dynamic components of gait. The assumptions we use are: 1) the camera is static and the only motion within the field of view is that of the moving person and 2) the subject is monitored by multiple cameras so that the subject presents a side view to at least one of the cameras. This is because the gait of a person is best brought out in the side view. The image sequence of that camera which produces the best side view is used. Our experiments were set up in line with the above assumptions.

We considered two image features, one being the width of the outer contour of the binarized silhouette, and the other being the binary silhouette itself. A set of exemplars that occur during a gait cycle is derived for each individual. To obtain the observation vector from the image features we employ two different methods. In the *indirect approach* the high-dimensional image feature is transformed to a lower dimensional space by generating the frame to exemplar (FED) distance. The FED vector captures both structural and dynamic traits of each individual. For compact and effective gait representation and recognition, the gait information in the FED vector sequences is captured using a hidden Markov model (HMM) for each individual. In the *direct approach*, we work with the feature vector directly and train an HMM for gait representation. The difference between the direct and indirect methods is that in the former the feature vector is directly used as the observation vector for the HMM whereas in the latter, the FED is used as the observation vector. In the direct method, we estimate the observation probability by an alternative approach based on the distance between the exemplars and the image features. In this way, we avoid learning high-dimensional probability density functions. The performance of the methods is tested on different databases

2.LITERATURE SURVEY

Literature review based on number of research papers on various approaches such as model based, appearance based for gait recognition as well as human recognition. Model-based approaches aim to describe both static and dynamic characteristics of a walking person. Using a finite number of model parameters for recognizing the human the necessary term is silhouetted image. Description an analysis of research is described below:

Gait Recognition by Neural Network:

NN ensemble appears to be a reasonable choice to address the gait recognition problem. The proof is found in, where walking human body parts are studied in a disjoint manner, and are shown to have markedly different discrimination potentialities. The outcome of combining the disjoint results, turns out to be more accurate, then considering them as a whole. Therefore, designing an NN ensemble, in form of a mixture of experts, each employed to classify one body part, and then mixing the outputs to get the final result, sounds rational. In this paper, an appearance-based gait recognition method is introduced. A learning vector quantization NN (LVQNN) ensemble is proposed in which, using the ability to disintegrate walking human body parts, each LVQNN deals with classification of one of body parts: face, upper-body and lower-body. The decision on the final class is made, based on the combination of all NN constituentoutputs. NNs are able to derive implied knowledge on the input/output relationship, and construct nonlinear decision boundaries on the input data, as it is, without necessity of any prior information, or imposing any assumptions or simplifications on the data. [1]

A multi-projection-based silhouette representation for individual recognition by gait is presented in “human identification using gait” by Murat Ekinci[3]. Recognizing people by gait intuitively depends on how the silhouette shape of an individual changes over time in an image sequence. Unlike other gait representations, which consider only foreground pixels in a bounding box surrounding as silhouette and one aspect of gait, the proposed method represents human motion as a multi-sequence of templates for each individual and considers all background pixels in the bounding box. Unlike other gait cycle estimationalgorithms, which analyze the variation of the bounding box data, the periodicity of gait is produced by analyzing silhouette data itself. The proposed algorithm has robustly estimated the periodicities in gait sequences obtained from all 3 views with respect to the image plane (lateral, oblique, and frontal). The approach for both gait cycle estimation and gait recognition is also fully automatic for real-time applications. In that algorithm is divided into three parts; human detection and tracking, feature extraction, and training and classification.

Model Based Approach Based on Fourier Series:

A model-based moving feature extraction analysis is presented by Cunado . It automatically extracts and explains human gait for recognition. First, the gait signature is extracted directly using the Fourier series to depict the motion of the upper leg and

then temporal evidence gathering techniques are applied in order to extract the moving model from a sequence of images. The potential performance benefits even in the presence of noise are highlighted by the results of the simulation. Classification makes use of the k-nearest neighbor rule applied to the Fourier components of the motion of the upper leg. It is illustrated from the experimental analysis that an enhanced classification rate is provided by the phase-weighted Fourier magnitude information when compared to the usage of the magnitude information. Gait recognition by using shape trace transform is presented by Porntep Theek Hanont andWerasakKurutach[8].In that approach the Euclidian distance for calculating the training data setisused.The input of the system is a binary silhouette from each frame which is converted from real time video or image .After that steps some noiseis deleted, the human body pictures are cropped and the gait period using the maximum width of human walking step is found. Next, the binary silhouettes are in one period which is transformed to different trace transform images. These transform images are used for calculating the average of trace transform images in a single period. In the following step the shape trace transform image are found by threshold and edge detection in the transform images. Finally the shape transform images they used the Euclidian distance and shape context arematched. They used the average filter for removing the noise from width value. Jang-HeeYoo,Doosung Hwang, Ki-Young Moon and Mark S. Nixon presented the neural network approach in" Automated Human Recognition by Gait using Neural Network" in which 2D stick figure is obtained .The 9 co-ordinates i.e. body points are extracted from the silhouetted image andthe stick figure is obtained by connecting the extracting coordinates Fig.2.1 shows the extracted stick figure. The stick figure is closely related to a joint representation, and the motion of the joints provides a key to motion estimation and recognition of the whole figure. The proposed method in this paper is recognizing the humans by using back-propagation neural network by their gait[7].

"Recognition of Affect Based on Gait Patterns" in this paper Michelle Karg, KoljaKühnlenz, and Martin Buss focus on all the knee joints and human emotions because human emotions affect the walking style of humans. . This approach collects all the data of joins and gait data and classifies this data by using naive classifier and NN.

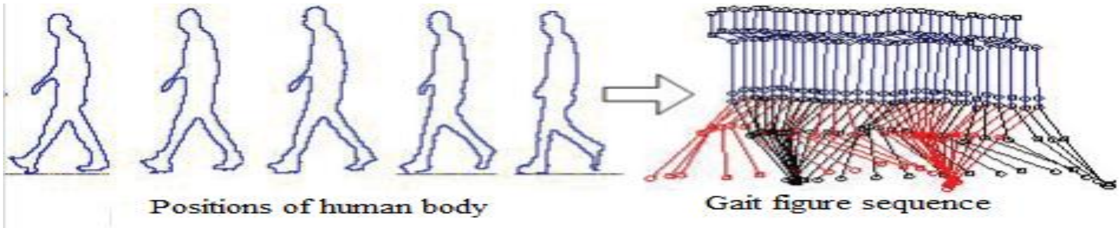

Figure 1: Gait Signature [5]

They address inter individual versus person dependent recognition. Recognition based on discrete affective states and recognition based on affective dimensions, and efficient feature extraction with respect to affect as compared to the temporal information by using Principal component analysis (PCA), kernel PCA, linear discriminant analysis, and general discriminant analysis in gait or extract relevant features for classification.

3.PROPOSED SYSTEM

The term "GAIT" refers to an individual's walking manner. In surveillance applications, it might be challenging to obtain facial or iris information at the resolution required for recognition. Studies in psychophysics reveal that individuals can recognise people from extremely impoverished presentations of gait, indicating the presence of identity information in Gait. Recognition based on how an individual moves has piqued the interest of defence and other agencies in remote surveillance or infrared records of movement in an area under covert monitoring. The method primarily involves dynamic mapping of the changing relationships of locations on a body.

Early work from the late 1980s built on biomechanics studies that dated. It centered on the 'stride pattern' of a sideways silhouette, with a few measurement points from the hip to feet. More recent research appears to be encompassing people in the round and seeking to address the challenge of identification in adverse conditions (eg at night, amid smoke or at such a distance that the image quality is very poor).

3.1 IMPLEMENTATION

1.Data Collection:

- Gather gait data from various sources such as motion capture systems, video recordings, or wearable sensors.
- Ensure the data collection environment reflects real-world scenarios to capture natural variations in walking patterns.

2. Segmentation:

- Segment the gait data into individual gait cycles, representing one complete walking cycle from heel strike to heel strike.
- Identify key events in the gait cycle, such as toe-off and heel strike, to establish temporal boundaries for segmentation.

3. Normalization:

- Normalize the gait data to account for variations in walking speed, stride length, and body size among different individuals.
- Standardize the temporal duration of gait cycles to align them based on specific events or phases, such as the mid-stance phase.

4. Alignment and Synchronization:

- Align gait cycles to a common reference point or phase to ensure temporal consistency across different samples.
- Synchronize gait data from multiple sensors or modalities to maintain temporal coherence in multi-sensor setups.

5. Noise Reduction:

- Apply noise reduction techniques to remove unwanted artifacts or disturbances in the gait data.
- Use digital filters or signal processing algorithms to smooth out irregularities caused by sensor noise or environmental factors.

6. Feature Engineering:

- Optionally, perform feature engineering to derive new features or enhance existing ones for better discrimination.

- Extract features related to temporal dynamics, such as gait cycle duration, swing phase duration, stance phase duration, and step cadence.

7. Quality Control:

- Conduct quality control checks to identify and mitigate data anomalies or outliers that may affect the accuracy of feature extraction.

- Exclude or flag data segments with poor signal quality or incomplete gait cycles to ensure reliable analysis.

8. Data Augmentation

- Augment the gait data to increase the diversity of training samples and improve the generalization of the authentication model.

- Generate synthetic gait data by applying transformations such as time warping, speed scaling, or perturbation of joint angles.

9. Normalization and Scaling:

- Normalize the feature values within a standardized range to prevent bias in feature importance during subsequent analysis.

- Apply scaling techniques such as z-score normalization or min-max scaling to standardize feature magnitudes across different dimensions.

10. Data Splitting:

- Split the preprocessed data into training, validation, and testing sets for model development and evaluation.

- Maintain the integrity of data splits to prevent information leakage and ensure unbiased performance assessment.

4.RESULTS AND DISCUSSION

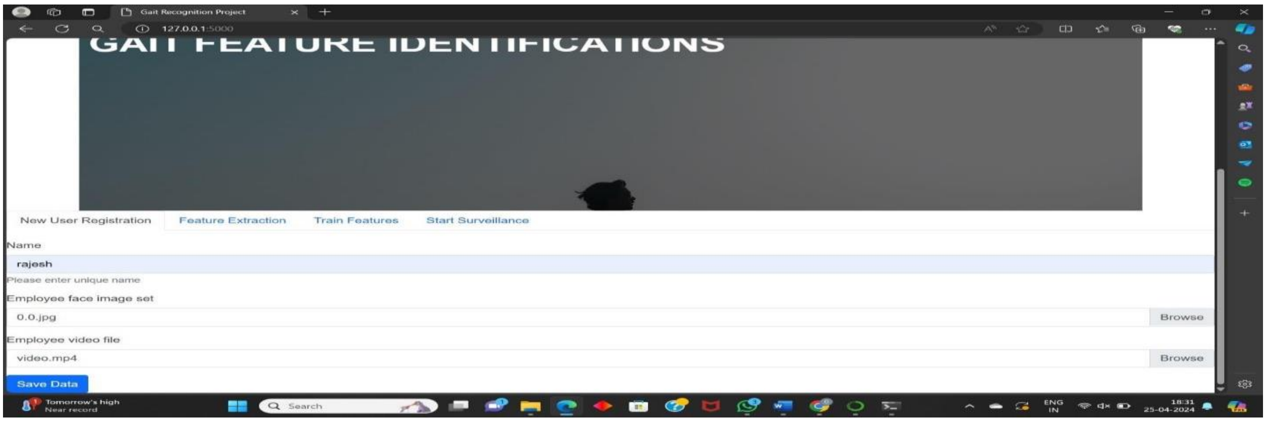

Fig: 2: New user registeration

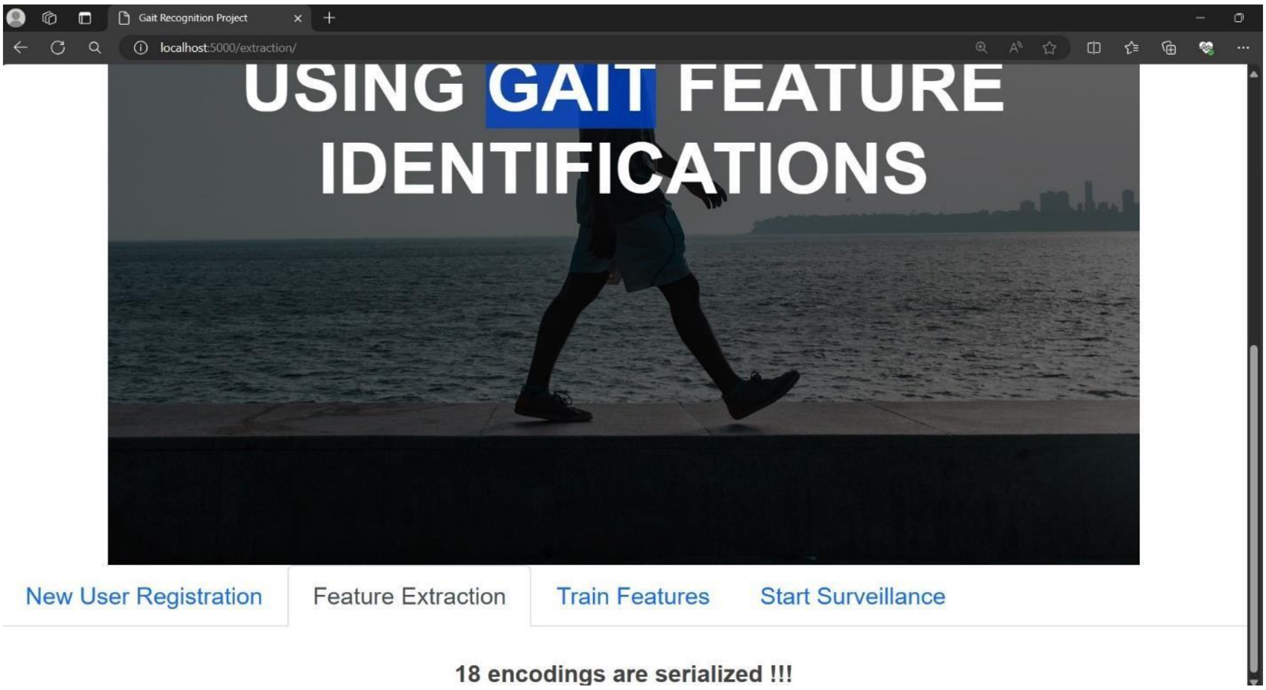

Fig 3: Feature extraction

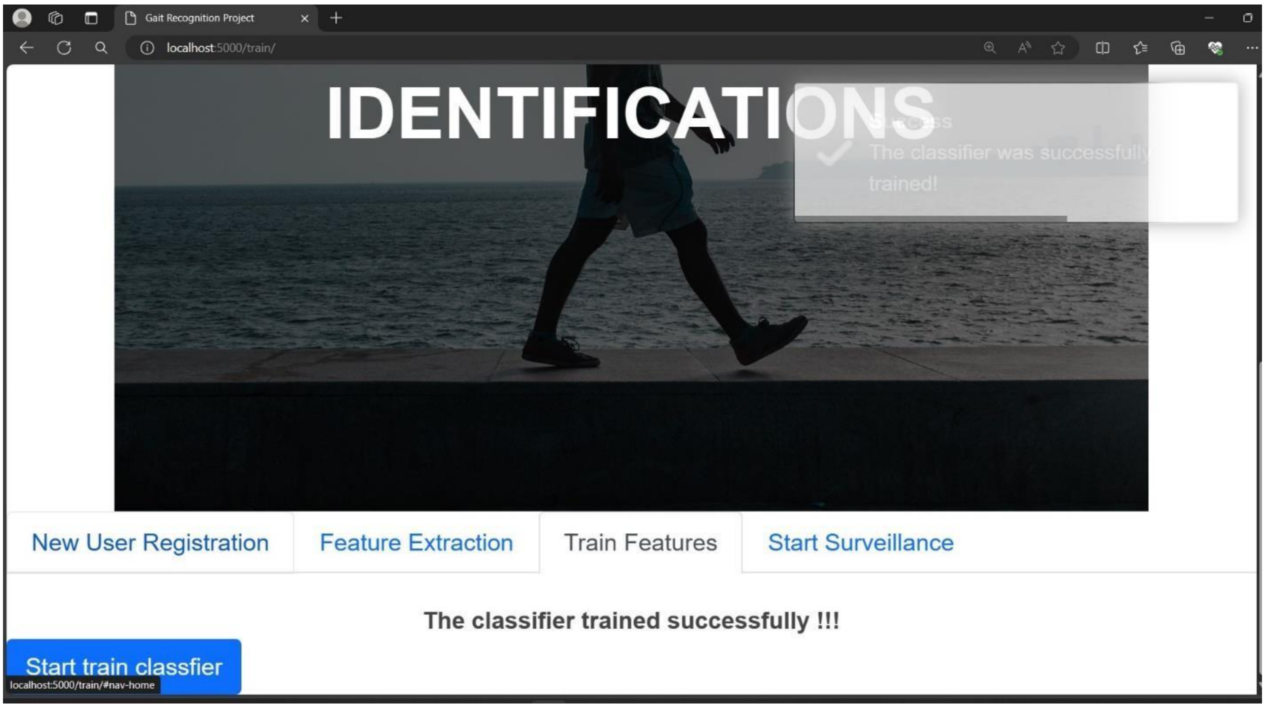

Fig 4: Train Features

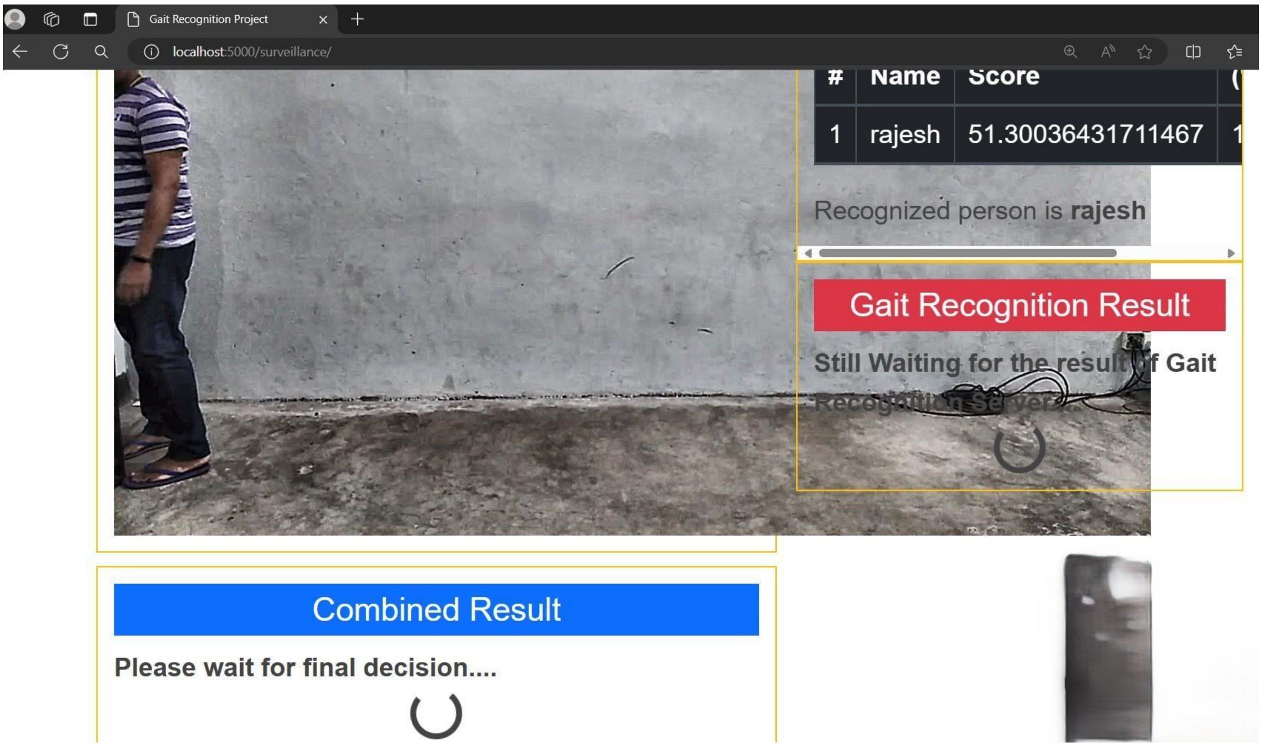

Fig 5: Result

5.CONCLUSION

We presented two ways for representing and recognising people based on their gait. Gait was represented by both the width of the outer contour of the binarized silhouette and the silhouette itself. In one method, a low-dimensional observation sequence is generated from silhouettes captured throughout a gait cycle, and an HMM is trained for each individual. Gait identification is done by calculating the likelihood that a given observation sequence was generated by a specific HMM model. The second method employed the distance between an image feature and an exemplar to determine the observation probability. The performance of the approaches was demonstrated using several gait databases.

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