

# GAIT Recognition using PAL and PAL entropy with LDA and MDA

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**Abstract:** Gait recognition is one kind of biometric technology that can be used to monitor people without their cooperation. The Gait shows a particular way or manner of moving on foot and gait recognition is the process of identifying an individual by the manner of walk. And Gait is less unobtrusive biometric; which offers the possibility to identify people at a distance; without any interaction or co-operation from the subject; this is the property which makes it so attractive [2]. This paper proposed new method for gait recognition. In this, firstly binary silhouette of a walking person is detected from each frame of an image. Then secondly, the features from each frame are extracted using the image processing operation. The step size length; centre of mass and cycle length are talking as key feature. In the end, LDA and MDA is used. Here, all experiments are done on gait database. At last in this paper, the result shows that the better improvement from the previous result by using LDA and MDA.

**Keywords:** Gait Recognition, Gait Pal and Pal Entropy (GPPE), LDA and MDA

## 1. Introduction

Recognition of an individual is an important task to the identify people. The identification through biometric is a better way because it associate with individual not with information passing from one place to another. Biometrics is a physiological or behavioural characteristic; which can be used to identify and verify the identity of an individual. There are numerous biometric measures which can be used to help derive an individual identity. They are physiological; like fingerprints; face recognition; iris-scans and hand scans and behavioural; like keystroke-scan and speech patterns. Gait recognition is relatively new biometric identification technology which aims to identify people at a distance by the way they walk. This has the advantage of being unobtrusive, difficult to conceal, non invasive and effective from a distance. The human gait recognition as a new biometric aimed to recognize person via the style of people walking, which contain the physiological or behavioural characteristics of human.

Gait recognition system can be classified depending on the sensors used into three groups namely; motion vision based, wearable sensor based and floor sensor based. The motion vision can be divided into two groups namely; appearance based methods and model based methods.

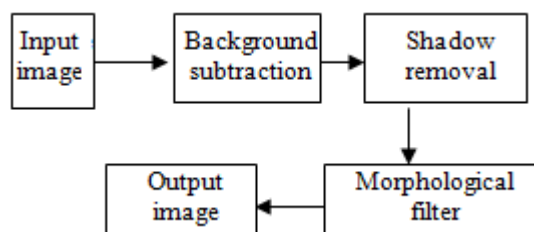


Figure 1: Silhouette extraction

The appearance based method can be also subdivided in two types; state space methods and spatial-temporal methods. Biometric gait recognition refers to verifying or identifying persons using their walking style. Human recognition based on gait is relatively recent compared to other biometric

approaches such as fingerprint, iris, facial etc [5, 6]. The wearable sensors and floor sensors systems are also able to identify persons but in different conditions compared to motion vision technique. The sensors may be set up on hip, legs, arms or other parts of the body. The floor sensors are put into the floor or on the floor which enable to detect the required measurement. The most important point is to match up testing dataset with training dataset to identify the subjects. Both systems are useful for access control such as office, airport, mega mall and other restricted places. Motion vision can be used for surveillance, access control, detection and other monitoring purposes [1, 3]. The most important advantage is that person walking image can be captured from long distance and the image is then processed with low resolutions. In this paper, we focus on two different techniques Principle Component Analysis (PCA) only and PCA with radon transform (RT) on machine vision for gait recognition purposes. In gait recognition, silhouette is defined as a region of pixels of the walking person. Silhouette extraction mainly focuses on segmenting the human body. The silhouette extraction process is shown in "Figure". Each of the frames in the image sequence is subtracted from a background model of the respective image sequence. If the pixel value of each frame is not the same with the pixel value of the background, the pixel is marked as region of silhouette. To remove shadow from the difference image, a threshold value is applied to the difference images. The difference image map is first analysed by generating the intensity histogram of the image so that the pixels distribution along the image can be represented clearly and in an effective way according to an applied threshold value. The threshold must be suitable so that the foreground image is neither under segmented nor over-segmented. Under-segmentation and over-segmentation purpose is to produce first and second reliable silhouette respectively. To remove noises produced during segmentation of silhouette, morphological filters are used. The main components of morphological filters that are used in the system are morphological opening, morphological closing and area thresholding through connected component labelling [7].

Model-based approaches employ models whose parameters are determined by processing of gait sequences (binary silhouettes). In these methods, parameters used as features are the height, the distance between head and pelvis, the maximum distance between pelvis and feet and the distance between feet. In, the silhouette of a walking person is divided in to some regions (generally seven regions). Subsequently, ellipses or rectangles are fit to each region and region feature vectors are determined. This includes averages of the centroid and the aspect ratio. Holistic methods operate directly on binary silhouettes without assuming any specific model for the walking human. The contour of the silhouette is the most reasonable feature in this method. For high quality binary silhouettes, width of outer contour of the silhouette was proposed as a suitable feature. For low quality binary silhouettes, the binary silhouette may be is used as a feature [4, 11].

## 2. Gait Recognition

The first important step towards preventing unauthorized access is user authentication. User authentication is the process of verifying identity. Traditionally password were set as a string which included integer or special characters and were used for authentication and these password can easily be cracked but now Biometric authentications are used. Biometric is a field of technology that uses automated methods for identifying and verifying a person. In real time applications like in banks, airports, authentications and verifications are always required. In such type of applications biometric identification methods are used.

Biometric characteristics are of two types:

- a) *Physiological*: These are biometrics which is derived from a direct measurement of a part of a human body. The most prominent and successful of these types of measures are Face, fingerprints, iris, palm print, DNA etc. These are related to body.
- b) *Behavioural*: Voice and Gait are related to behaviour of the person. Extract characteristics based on an action performed by an individual, they are an indirect measure of the characteristic of the human form. The main feature of a behavioural biometric is the use of time as a metric. Established measures include keystroke-scan and speech patterns. Biometric identification should be an automated process. Manual feature extraction would be both undesirable and time consuming, due to the large amount of data that must be acquired and processed in order to produce a biometric signature. Inability to automatically extract the desired characteristics which would render the process infeasible on realistic size data sets, in a real-world application.
- c) *Gait Analysis*: Gait analysis is the systematic study of human locomotion, augmented by instrumentation for measuring body movements, body mechanics and the activity of the muscles. Gait based recognition is more suitable in video surveillance applications because of following advantages:
  - 1) Recognition using gait do not need any user cooperation.
  - 2) The gait of an individual can be captured at a distance.

- 3) Gait recognition does not require images of very high quality and provide good results in low resolution.
- 4) Gait recognition aiming to identify the individuals by the way he walk or move.
- d) **Approaches for Gait Recognition**:  
Some basic methods or approaches for gait recognition [10]:
  - 1) **Moving Video based gait recognition**: In this approach, gait is captured using a video-camera from a distance. Video and image processing techniques are employed to extract gait features for recognition purposes. For example stride, cadence, static body parameters, etc.
  - 2) **Floor Sensor based gait recognition**: In this approach, a set of sensors or force plates are installed on the floor and such sensors enable to measure gait related features, when a person walks on them, e.g. maximum time value of heel strike, maximum amplitude value of the heel strike, etc.
  - 3) **Wearable Sensor based gait recognition**: In this approach, gait is collected using body worn motion recording (MR) Sensors. The MR sensors can be worn at different locations on the human body. The acceleration of gait, which is recorded by the MR sensor, is utilized for authentication [7, 8].
- e) **Steps of Gait Recognition System**:
  - 1) **Background Subtraction**: In this approach moving objects from background in the scene are identified first. Then some of the background subtraction techniques are applied on it. A common approach is to perform background subtraction, which identifies moving objects from the portion of video frame that differs from the background model. Background subtraction generates binary images containing black and white (moving pixels) also known as binary silhouettes. Background subtraction is a class of techniques for segmenting out objects of interest in a scene for applications such as surveillance. There are many challenges in developing a good background subtraction algorithm. First, it must be robust against changes in illumination. Second, it should avoid detecting non-stationary background objects such as moving leaves, rain, snow, and shadows cast by moving objects. Finally, its internal background model should react quickly to changes in background such as starting and stopping of vehicles.
  - 2) **Pre-processing**: Silhouette segmentation is the first step to gait recognition. Pre-processing is done on video frames to reduce presence of noise then some filters are applied which in turns blur the frames of image, which \*helps in shadow removal, after pre-processing motion detection is performed. Background subtraction technique uses the difference of current image and background to detect the motion. It delineates the foreground from background in the image. Background subtraction generate binary image containing black (background) and white (moving pixel), then post processing is applied to obtain normalized silhouette images with less noise. They used morphological operators such as dilation and erosion to fill small holes inside silhouette and to filter small noise on the background.

To reduce computational cost they proposed new silhouette representation method which only uses some of pixel on the contour.

- 3) Feature Extraction: Feature extraction is a special form of dimensionality reduction. When the input data is too large to be processed and it is suspected to be notoriously redundant (e.g. the same measurement in both feet) then the input data will be transformed into a reduced representation set of features (also named features vector). Transforming the input data into the set of features is called feature extraction.
- 4) Recognition: This is the final step of human identification using gait. In this step input videos are compared with sequences stored in database. Different types of classifiers are used for the recognition. Such as: MDA (Multi-linear discriminant analysis), LDA (Linear Discriminant Analysis). They use MDA approach to optimize the separability of gait features.
- f) Gait Recognition System:  
System will identify unauthorized individual and compare his gait with stored sequences and recognize him. Background subtraction is the common approach of gait recognition. Background subtraction method is used to subtract moving objects and to obtain binary. Using background subtraction, pre-processing is done to reduce noise. Gait recognition method contains two parts
  - 1) Training part
  - 2) Testing part

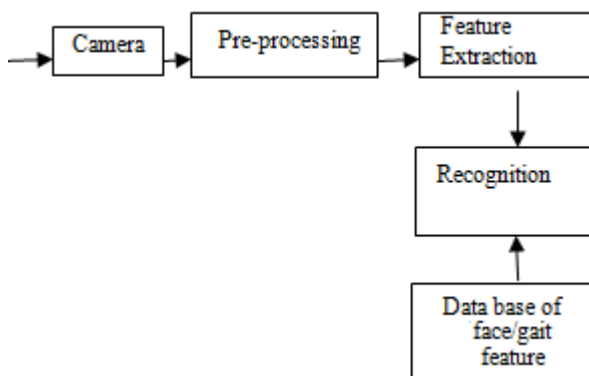


Figure 2: Block diagram of Gait Recognition System.

Gait analysis laboratory has several cameras (video or infrared) placed around treadmill, which are directly linked to a computer. The person has markers located at various points of body (e.g. spines of the pelvis, ankle malleolus) [10]. When person walks down the treadmill and the computer calculates the trajectory of each marker in three dimensions. A model is applied to calculate the movement of bones.

### 3. Linear Discriminant Analysis (LDA)

Linear Discriminant Analysis (LDA) is a techniques used for data classification and dimensionality reduction. In PCA, the shape and the location of the original data sets changes when transformed to a different spaces whereas LDA doesn't change the location but only tries to provide more class separability and draw decision between the given classes. In discriminant analysis, two scatter matrices, called *within-*

*class* ( $S_w$ ) and *between-class* ( $S_b$ ) matrices are defined to quantify the quality.

$$S_w = \sum_{i=1}^k \sum_{x \in \pi_i} (x - m_i)(x - m_i)^T \text{ and } S_b = \sum_{i=1}^k (m_i - m)(m_i - m)^T, \text{ where}$$

$$n_i = \frac{1}{n_i} \sum_{x \in \pi_i} x \text{ is the mean of the } i\text{th class, and } m = \frac{1}{n} \sum_{i=1}^k \sum_{x \in \pi_i} x \text{ is the global mean.}$$

### 4. Multi-Linear Discriminant Analysis (MDA)

MDA has the following characteristics:

- 1) Multiple interrelated subspaces can collaborate to discriminate different classes.
- 2) The MDA algorithm can avoid the curse of dimensionality and serves the small sample size problem
- 3) The computational cost in the learning stage is reduced.

$$S_B = \sum_{j=1}^{l_0 \neq k^{m_0}} S_B^j, \quad \sum_{c=1}^{N_c} n_c (Y_c^{k,j} - \bar{Y}^{k,j})(Y_c^{k,j} - \bar{Y}^{k,j})^T$$

$$S_W = \sum_{j=1}^{l_0 \neq k^{m_0}} S_W^j, \quad S_W^j = \sum_{i=1}^{N_i} (Y_i^{k,j} - \bar{Y}_i^{k,j})(Y_i^{k,j} - \bar{Y}_i^{k,j})^T$$

Where

$$Y_i = X_i X_1 U_1 \dots X_{k-1} U_{k-1} X_{k+1} U_{k+1} \dots X_n U_n$$

### 5. Conclusion

Gait recognition has been proposed previously but there have been always need for better gait recognition technique. The existing human identification using gait recognition doesn't consider some important parameters like distance between hands and thus it is poor in quality. The existing human identification using gait recognition algorithm is costlier. Therefore, propose an enhanced human identification using gait recognition algorithm which is based on pal and pal entropy LDA and MDA. Our enhanced human identification using gait recognition algorithm is low cost and more accurate. Our enhanced human identification using gait recognition algorithm is fast and thus saves time.

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### References

- [1] H. F. Alan J. Lipton and R. S. Patil, "Moving target classification and tracking from real-time video," Proceedings of Fourth IEEE Workshop on Applications of Computer Vision (WACV'98).
- [2] A. N. R. N. P. C. A. K. R.-C. V. K. Amit Kale, Aravind Sundaresan and R. Chellappa, "Identification of humans using gait," IEEE Transactions on Image Processing, vol. 13, no. 9.

- [3] A. K. R.-C. Aravind Sundaresan and R. Chellappa, "A hidden markov model based framework for recognition of humans from gait sequences," Proceeding of ICIP.
- [4] M. Bober, "Mpeg-7 visual shape descriptors," IEEE Transactions on Circuit and Systems for Video Technology, vol. 11, no. 6.
- [5] H. Z. Changhong Chen, Jimin Liang and H. HU, "Gait recognition using hidden markov model," Lecture Notes on Computer Science.
- [6] P. S. Huang, "Automatic gait recognition via statistical approaches for extended template features," IEEE Transaction on Systems, Man, and Cybernetics-Part B: Cybernetics, vol. 31, no. 5, October 2001.
- [7] L. Lee and W. E. L. Grimson, "Gait analysis for recognition and classification," Proceedings of Fifth IEEE International Conference on Automatic Face and Gesture Recognition., 2002.
- [8] W. H. Liang Wang, Tieniu Tan and H. Ning, "Automatic gait recognition based on statistical shape analysis," IEEE Transaction on Image processing, vol. 12, no. 9, September 2003.
- [9] "Silhouette analysis-based gait recognition for human identification," IEEE Transaction on Image processing, vol. 25, no. 12, December 2003.
- [10] D. H. Nikolaos V. Boulgouris and K. N. Plataniotis, "Gait recognition: A challenging signal processing technology for biometric identification," IEEE signal processing magazine, November 2005.
- [11] M. Piccardi, "Background subtraction techniques: A review," IEEE International Conference on Systems, Man and Cybernetics.
- [12] P. W. Power and J. A. Schoonees, "Understanding background mixture models for foreground segmentation," Proceedings of IEEE International Conference on Image and Vision Computing.
- [13] C. Stauffer and W. E. L. Grimson, "Adaptive background mixture models for real-time video tracking," Proceedings of IEEE Computer Society Conference on Computer Vision and Pattern Recognition, vol. 82, pp. 246–252.