Biometric Authentication system using gait features as Biometric Trait

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Abstract— **Gait recognition is the main field of biometric authentication system Gait is a particular way of moving on foot. Gait of a person has some drawback that gait of a person modify with age emotion, variation in clothing and footwear's. Gate reorganization is done by using image silhouette. In this various approaches has been utilized for the process of gait reorganization. These approaches utilized feature extraction from silhouette Image's. On the basis of energy and enthalpy level available in different images. But energy and enthalpy does not provide accurate information about gait. To remove these issue in the field of gait reorganization process the approach has to utilize which extract optimal feature for gait reorganization process**

Index Terms— **Gait recognition, Gait Cycle, FAR & FRR**

I. INTRODUCTION

1.1 Gait Recognition

Gait recognition is an emerging biometric technology which involves people being identified purely through the analysis of the way they walk. While research is still underway, it has attracted interest as a method of identification because it is non-invasive and does not require the subject's cooperation. Gait recognition could also be used from a distance, making it well-suited to identifying perpetrators at a crime scene. But gait recognition technology is not limited to security applications – researchers also envision medical applications for the technology.

For example, recognizing changes in walking patterns early on can help to identify conditions such as Parkinson's disease and multiple sclerosis in their earliest stages [1]. Gait recognition technology is, however, still in its developing stages. No model has, as of yet, been developed that is sufficiently accurate and marketable.

The technology is moving ahead at a rapid pace; however, with government-sponsored projects supporting research such as that going on at the Georgia Institute of Technology, MIT, the Lappeenranta University of Technology, and others academic institutions.

1.2 Types of Gait Reorganization

- **Automatic analysis of video imagery**- This is the more widely studied and attempted of the two. Video samples of the subject's walk are taken and the trajectories of the joints and angles over time are analyzed. A mathematical model of the motion is created, and is subsequently compared against any other samples in order to determine their identity.
- **Radar system** –This is used by police officers to identify speeding cars. The radar records the *gait cycle* that the various body parts of the subject create as he or she walks. This data is then compared to other samples to identify them.

Efforts are being made to make gait recognition as accurate and usable as possible, and while it may never be as reliable as other biometrics such as fingerprint or iris recognition, it is predicted that gait recognition technology will be released in a functional state within the next five years, and will be used in conjunction with other biometrics as a method of identification and authentication [4].

1.3 Gait Cycle:

A Gait Cycle is the time period or sequence of events or movements during locomotion in which one foot contacts the ground to when that same foot again contacts the ground, and involves forward propulsion of the centre of gravity of human body consisting alternate sinuous moments of different segments of the body with least expenditure of energy. A single gait cycle is also known as a stride.

- **Phases of Gait Cycle**

Stance Phase, the phase during which the foot remains in contact with the ground.

Swing Phase, the phase during which the foot is not in contact with the ground.

- **Components of Gait Cycle**

Stance Phase: The stance phase is that part of a gait cycle during which the foot remains in contact with the ground. For analyzing gait cycle one foot is taken as reference and the movements of the reference foot are studied. It constitutes of 60 percent of the gait cycle. In stance phase the reference foot undergoes five movements [8]:

Initial Contact (Heel Strike): In initial contact, the heel is the first bone of the reference foot to touch the ground.

Loading Response (Foot Flat): In loading response phase, the weight is transferred onto the referenced leg. It is important for weight-bearing, shock-absorption and forward progression.

Mid Stance: It involves alignment and balancing of body weight on the reference foot.

Terminal Stance: In this phase the heel of reference foot rises while the toe is still in contact with the ground.

Toe Off (Pre Swing): In this phase, the toe of reference foot rises and swings in air. This is the beginning of the swing phase of the gait cycle [7].

Swing Phase: The swing phase is that part of the gait cycle during which the reference foot is not in contact with the

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ground and swings in the air. It constitutes about 40% of gait cycle. It has three parts:
Initial Swing
Mid Swing
Terminal Swing

1.3 ALGORITHM USED

2DPCA

A straightforward image projection technique, called two-dimensional principal component analysis (2DPCA), is developed for image feature extraction. As opposed to conventional PCA, 2DPCA is based on 2D matrices rather than 1D vector. That is, the image matrix does not need to be previously transformed into a vector. Instead, an image covariance matrix can be constructed directly using the original image matrices. In contrast to the covariance matrix of PCA, the size of the image covariance matrix using 2DPCA is much smaller. As a result, 2DPCA has two important advantages over PCA. First, it is easier to evaluate the covariance matrix accurately. Second, less time is required to determine the corresponding Eigen vectors. The main ideas of the PCA and 2DPCA methods are to find the vectors that best account for the distribution of target images within the entire image space. In the general PCA /2DPCA method, eigenvectors are calculated from training images that include all the poses or classes. But for classification a large number of hand poses for a large number of users, need large number of training datasets from which Eigen vectors generation is tedious and may not be feasible for a personal computer.

II. REVIEW OF LITERATURE

Singh, J.P. et al [1] “Person identification based on gait using dynamic body parameters” Gait as a behavioral biometrics has been the subject of recent investigations. One of the unique advantages of human gait is that it can be perceived from a distance. A varied range of research has been undertaken within the field of gait recognition. A gait describes the manner of a person's walking. It can be acquired at a distance and if necessary without consent or knowledge of the subject. Human gait representation can be roughly divided into two categories. One is model-based gait approach and other is model free gait approach. A human body feature that contributes more to an automatic gait classification is subdivided into two i.e. static (body shape) or dynamic (the movement of legs and arms). In this research work, we have considered dynamic features of human body for gait recognition. In our proposed research work, we have considered two features of human body i.e. hand and feet for gait recognition. Second feature feet are subdivided into two i.e. toe and heel. Both left and right legs toe and heel are considered. We follow an approach of parametric line equation for formulating two triangles between these features i.e. first triangle is formed between hand and toe of both legs(right and left) and second triangle is formed between same hand and heel of both legs(right and left). After triangles formation we have find two intersecting points between these triangles and angles at these intersecting points.

Jianning Wu et al [2] “A new intelligent model for automated assessment of elder gait changes” This paper addressed a novel intelligent model for automatic evaluation of the change of elder gait function based on kinematic gait data. In order to recognize the change of elderly gait patterns with higher accuracy, the wavelet analysis technique was proposed as a new approach to extract gait features, and then those obtained gait features were initiated the training set of gait classifier such as artificial neural network (ANN). The gait data of two groups including young and old subjects were acquired during normal walking, and were analyzed using the proposed method. The experimental results indicated that the gait features exacted by the wavelet analysis technique, as the input of ANN could provide more discriminating information than the traditional gait features selected such as maximal value or values obtained from the different occurrences based on gait events, and the proposed classification model could identify young and elderly gait patterns with higher accuracy. It is hopeful that the proposed model can be used as an effective tool for diagnosing the change of gait function for old people in clinical application.

Begg, R.K et al [3] “Support vector machines for automated gait classification” Ageing influences gait patterns causing constant threats to control of locomotors balance. Automated recognition of gait changes has many advantages including, early identification of at-risk gait and monitoring the progress of treatment outcomes. In this paper, we apply an artificial intelligence technique [support vector machines (SVM)] for the automatic recognition of young-old gait types from their respective gait-patterns. Minimum foot clearance (MFC) data of 30 young and 28 elderly participants were analyzed using a PEAK-2D motion analysis system during a 20-min continuous walk on a treadmill at self-selected walking speed. Gait features extracted from individual MFC histogram-plot and Poincare´-plot images were used to train the SVM. Cross-validation test results indicate that the generalization performance of the SVM was on average 83.3% (±2.9) to recognize young and elderly gait patterns, compared to a neural network's accuracy of 75.0±5.0. A "hill-climbing" feature selection algorithm demonstrated that a small subset (3-5) of gait features extracted from MFC plots could differentiate the gait patterns with 90% accuracy. Performance of the gait classifier was evaluated using areas under the receiver operating characteristic plots. Improved performance of the classifier was evident when trained with reduced number of selected good features and with radial basis function kernel. These results suggest that SVMs can function as an efficient gait classifier for recognition of young and elderly gait patterns, and has the potential for wider applications in gait identification for falls-risk minimization in the elderly.

Huifeng Zhang et al [4] “Research on healthy subject gait cycle phase at different walking speeds” The human gait cycle phase is an important parameter which is used to reflect the characteristics of human gait. In this paper, the gait cycle phase was divided into six parts based on clinical manifestations of common abnormal gait. According to the sole's position and orientation during a gait cycle, flexion and extension angles of the sole were defined. The largest Lyapunov exponent (LE) and average power were introduced to reflect the stability and energy expenditure of human body under different walking speeds. The healthy subjects' gait parameters data under different gait speeds were captured through motion capture system. The experimental results showed that, in order to adapt to different walking speeds, human gait cycle and other characteristic parameters were adjusted. In this paper, the reason why the stance time changed was pointed out. The body's stability decreased with the increase of walking speed, however, the average power value increased. The results provided a basis for gait evaluation and gait planning of lower limb rehabilitation training robot.

Che-Chang Yang et al [5] “Real-time gait cycle parameters recognition using a wearable motion detector” This paper presents the use of an accelerometer-based wearable motion detector for real-time recognizing gait cycle parameters of Parkinson's disease (PD) patients. The wearable motion detector uses a tri-axial accelerometer to measure trunk accelerations during walking. By using the autocorrelation procedure, several gait cycle parameters including cadence, gait regularity, and symmetry can be derived in real-time from the measured trunk acceleration data. The gait cycle parameters derived from 5 elder PD patients and 5 young healthy subjects are also compared. The measures of the gait cycle parameters between the PD patients and the healthy subjects are distinct and therefore can be quantified and distinguished, which indicates that detection of abnormal gaits of PD patients in real-time is also possible. The wearable motion detector developed in this paper is a practical system that enables quantitative and objective mobility assessment. The possible applications of this system are also discussed.

III. PROBLEM FORMULATION

Gait recognition is the main field of biometric authentication system Gait is a particular way of moving on foot. Gait of a person has some drawback that gait of a person modify with age emotion, variation in clothing and footwear’s. Gait image has been covered under gait cycle. Different person utilize different gait step on different situation. Gate reorganization is done by using image silhouette.

Image silhouette is formed by subtracting background from an image. And formation of different gait cycle from different frames, In this various approaches has been utilized for the process of gait reorganization. These approaches utilized feature extraction from silhouette Image’s. On the basis of energy and enthalpy level available in different images. But energy and enthalpy does not provide accurate information about gait. To remove these issue in the field of gait reorganization process the approach has to utilize which extract optimal feature for gait reorganization process.

IV. PROPOSED WORK

Gait recognition is the process of biometric trait recognition. In this process the different gait cycles of persons have been used for recognition process. In this process the features have been evaluated from different gait cycles using different approaches. In the purposed work the gait cycles have been used for extraction of features. 2-Dimenssional Principal Component analysis has been used for extraction of the features from the different gait cycles. This approach generates 2 dimensional covariance matrixes for the gait cycle images. The co variance matrix is used for development of Eigen values and Eigen vector.

In the purposed methodology the mean of the gait cycle is computed and the mean of the gait cycle image has been subtracted and mean subtracted image is computed from gait cycle.

$$\Psi = \frac{1}{N}\sum_{i=1}^{N} X_i \qquad (1)$$

This purposed approach that has been used for extraction of mean image by using equation (1). Then the mean subtracted image is computed by using subtracting the mean image from all training images.

$$\Phi = X - \Psi \qquad (2)$$

The mean subtracted image has been computed by subtracted the mean image from the training image. After this process the variance matrix A Computed from these mean subtracted image that is 2 d variance matrix directly developed from the image.

$$M = A.A^T \qquad (3)$$

After this process the Eigen features and the Eigen values for the gait has been computed that is used the covariance matrix and subtracted image. The Eigen value μ_i and Eigen vector v_i has been computed on the basis different equations that are represented as.

$$M.v_i = \mu_i.v_i \qquad (4)$$

By using the Eigen values and Eigen vectors Eigen face matrix has been generated that is used as features for matching purposes.

It is product of variance of each face image with d numbers of highest Eigen vectors.

$$\Phi = A\ .v \qquad (5)$$

After the generation of Eigen face the matrix is computed by using different images and system is trained. The database features has been stored. These features have been used for matching with test gait cycles on the basis of Manhattan distance classifier.

$$d = \sum_{i=1}^{N} |x_i - y_i| \qquad (6)$$

The distance classifier computes the distance between test gait cycles and training image gait cycle. The minimum distance between the images of testing dataset and training dataset is maximum matched cycle.

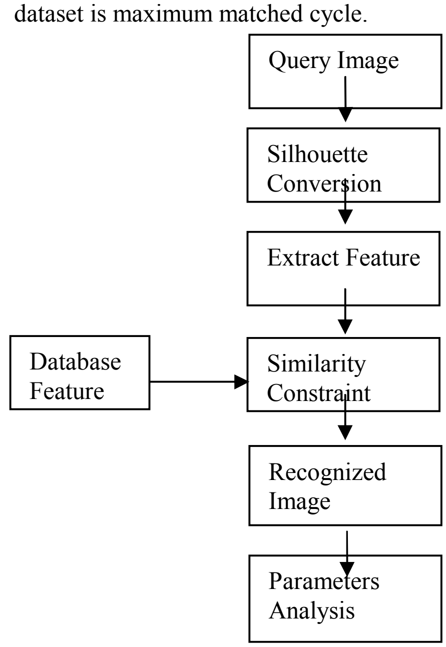

Fig 4.1 Flow of Purposed Work

This figure represents the steps that have to be carried out for gait recognition using 2DPCA.

V. RESULTS AND DISCUSSIONS

Gait recognition is a part biometric authentication system that use for various authentication purposes. In the process of gait recognition different gait samples have been used for recognition. In the purposed work CASIA-A gait database has been used for gait recognition in this process different gait images have been used for gait recognition process. In this database different samples have been acquired from different persons at various angles. This database contains the gait samples at 0º, 45º and 90º. These samples have been taken at different time instances. The 4 samples are available for each degree angle.

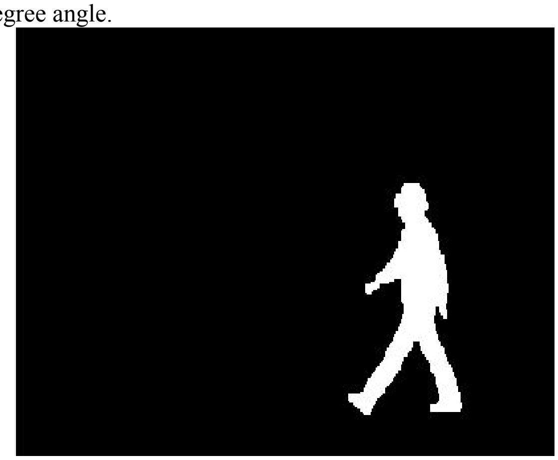

Fig 5.1 Gait Cycle at 0º angle

This figure represents gait cycle at 0º angle. The gait cycle changes due to variation in the angle that has been represents below. The variation in the angle can change the feature value for the gait cycle.

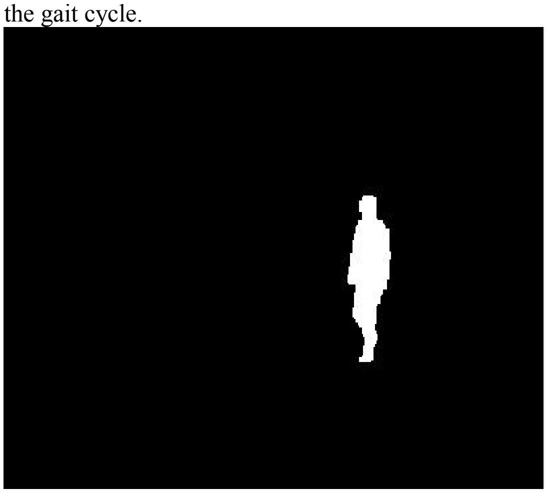

Fig 5.2 Gait Cycle at 45º angle

This figure represents gait cycle at 0º angle. As the variation in angle of capturing gait varies the style of a gait get varies and feature will be get varies. The variation in the feature values can affect the accuracy for gait recognition. The accuracy has been measured at same angle of the purposed system because due to variation in the angle the accuracy of purposed system get decrease.

Fig 5.3 Gait Cycle at 90º angle

This figure represents gait cycle at 0º angle. The gait cycle changes due to variation in the angle that has been represents below.

In the purposed work the accuracy has been measured at different angles of gait. In the gait representation different angles data has been used for gait recognition. The samples have been used for training of gait recognition system and features have been computed. After this testing samples of same angles has been used for gait recognition and the accuracy of purposed work has to be computed.

Gait angle	Purposed	Previous
Left to left	93.75 %	73.68 %
Left to right	81.25%	26.3%

Table 5.1 Accuracy table for gait recognition

This table represents the accuracy for the gait recognition system when tested at different angles of gait. The accuracy has been measured for different angles by using 2DPCA approach and Manhattan classifier. The Manhattan classifier provides better accuracy for gait recognition system. The purposed work provides better accuracy than the previous approaches.

CONCLUSION

Gait recognition is the process that has been used in biometric authentication systems. The different gait samples have been used for gait recognition process. In the process the features from training and testing data samples has been computed and on the basis of these features different techniques have been used for gait recognition the validation of system has to be described. In the purposed work 2 dimensional principal component analysis is used for extraction of features. And Manhattan distance classifier is used for distance measurement between database features and test image features. In this paper by analyzing the purposed work accuracy one can conclude that the purposed work provide better accuracy than previous approaches.

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