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EVALUATING THE EFFECT OF VIEWING ANGLE IN DIFFERENT CONDITIONS FOR GAITRECOGNITION

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ABSTRACT

Gait recognition has gained interest of researchers as it performs identification of subjects at a distance from the camera. However, due to the changes in the viewing angles, it gets cumbersome for a system to perform recognition based on the walking pattern of an individual. In this work, the aim is to present a baseline method for the purpose of human recognition based on the shape of its body and walking pattern when the subject is observed from different viewing angles. The recognition is also tested on the subject in two different scenarios, apart from being observed at different viewing angles. Gait periodicity is estimated after extracting the silhouettes of an individual, followed by obtaining the total silhouette representation of an individual using Matlab. The total silhouette representations obtained from the probe gait data are compared to the gallery gait data representations for the purpose of similarity computation by calculating the RMS value between the said representations. Higher the value, lesser is the similarity & vice versa. The experiments are conducted on the CASIA gait dataset and obtained the gait recognition rate ranging from 23% to 69% in different scenarios. The results show that the proposed method outperforms the other existing methods & puts a decent fight to the base algorithm.

Keywords: gait, biometric systems, human gait recognition system, identification, walking pattern, strolling.

1. INTRODUCTION

Security has turned into one of the significant concerns, with the advent of engineering and technologies in the present day world. Being humans we generally attempt to gain entrance to any framework with ease. Generally, people use passcodes, pins and multiple other techniques to keep their data or information from falling in wrong hands or being misused. With the constant increase in the number of threats, researchers are trying to develop systems that will identify the person/subject and prove their originality based on some unique and distinct features of that particular subject. Individuals can lose or forget their passwords and pins or can be stolen as well; hence a strategy was created that focused around the unique features of the individual. This is referred to as biometrics.

Biometrics is defined as the computerized implementation of physical or behavioral characteristics to confirm the identification of an individual [1]. Physiological biometrics is relevant to shape of parts of the body and is more consistent. These include finger prints, face identification, retina scanning etc. Behavioral biometrics which involves gait, voice, signatures and speech identification etc are related to actions and activities of an individual and can be more vulnerable to changes based on factors such as ageing, accidents and feelings. Biometrics is a division of computer vision which is used for large numbers of programs, which range from simple programs like - offering time and presence performance for your small business to extensive and complicated - guaranteeing the reliability of a ten million person voter signing up data source. Based on the application, the benefit of using or implementing biometrics may be improved security, improved comfort, reduced scams, or distribution of improved services [2].

We define gait to be the synchronized, cyclic mixture of movements that results in locomotion [3]. The movements are synchronized in the sense that they must take place with a specific temporary design for the gait to happen. It is the cyclic nature and the synchronization both, of the human locomotion that makes gait unique for every individual. Activities like strolling, running, walking & going up the stairways, taking a seat, picking up an item, and tossing an item are examples of synchronized movements, but not cyclic. Jumping jacks are synchronized and cyclic, but these do not outcome in locomotion. Hence, in accordance with the synchronized and cyclic movements, the recognition of some significant property, e.g., identification, pattern of strolling or pathology that results in personal locomotion will be the appropriate definition for the gait recognition. Gait recognition offers identification from a distance and at low resolution as well, this attribute gives gait an exclusive edge over the other biometric techniques [4]. For instance if we take any picture of a personal strolling from a monitoring camera, it can be seen that the hands are at too low picture for recognition by shape; it would be useless even to attempt to identify individuals by eye or finger marks design.

In multiple scene-of-crime information, the situation is amplified by low quality video information or by inadequate lighting. In contrast an individual's gait is often easily obvious in a picture series. Identification can be concealed in a secret way quite quickly. Gait recognition can handle such situations and might even answer the question as to whether the topic is actually a "him", or whether it is likely that the topic was actually female. Gait recognition can be in accordance with the (static) personal form & on activity, indicating a better identification cue. It is actually one of the latest biometrics since its growth is contemporaneous with new techniques in spatiotemporal picture handling and PC perspective. These new techniques need good memory and handling speed to procedure series of picture information with reasonable performance. These improvements can be used for guidance: in medical research or to observe its effects on person's gait, work in mindset has already inspired recognition techniques. Such improvements also offer proof that facilitates the idea of gait as a biometric. People often think that they can recognize an individual from very far simply by acknowledging the style & pattern, a subject is walking [5].

As a biometric, gait possesses multiple qualities. Pictures can be captured with simple devices & does not need attention of the person going through the investigation. In reality, it is quite possible that an individual may not be aware of the monitoring and recognition [3].

Studies [6] have demonstrated that gait marks acquired from video can be utilized as a dependable signal to recognize people. These discoveries [7] enlivened analysts in computer and machine vision to concentrate potential stride marks from pictures to distinguish individuals. It is testing, however, to discover quirky step gimmicks in marker-less motion arrangements, where the utilization of markers is not used on the grounds that it is meddling and not suitable in general step distinguishment settings.

Human gait identification is an exigent exercise in a multiple number of applications, for example, access control, security, observation, surveillance, and so on. To recognize different people by the style they will walk is a characteristic undertaking individual perform daily [8].

As a biometric, it also faces some limitations. Compared with fingerprints, we do not know the extent to which our step is exclusive. Furthermore, there are other aspects that cause modifications in gait, such as shoes, landscape, exhaustion, aging, and injury.

2. ANALYSIS OF EXISTING APPROACHES

The biometric methods for authenticating and determining people are used in both the professional and private industry. The present, from the professional perspective available biometric techniques show excellent stability though. However, they generally lack customer acceptance [9]. Customers revealed an antipathy towards in contact with a possibly unclean finger print scanning device, or looking into an eye scanning device that might breakdown and gradually damage their eyes. Whether those worries are well established or not is of minimal significance. The fact is they have significant impact on customer approval.

At the same time, recent gait recognition systems suffer from the challenges that mostly involve viewing angle variations. And it is important for an excellent and effective application of a biometric system, as well as for excellent identification rates.

In reaction to the improving demand for services for efficient as well as simple to use biometric techniques this work examines the usefulness of gait as a biometric function for verification. Using this biometric, would avoid such problems, since it needs no individual's connections other than walking in front of a specific camera.

3. RELATED WORKS

Gait recognition can be determined by a various number of dynamic parameters that involve angles, velocity, speed and angular acceleration of joints and so on. Taking model based (also known as joint trajectory based or static parameter based) methods into account, [10] introduced a gait recognition strategy focused around the gimmick of limb angles. This methodology based on their algorithm included firstly, getting the profiles of strolling individuals by subtraction of the background, then extraction of frames by cyclic gait investigation took after by registering the directions of body joints as per the individuals geometry demonstrated while walking. Taking into account those directions, the limb angles are figured and afterward made discrete Fourier transform (DFT). Finally the closest neighbor classifier is performed to order subjects.

A five connection bipedal movement human model was proposed by [11] which first concentrate the gait characteristics from the pictures utilizing the Metropolis-Hasting technique. HMM's were then prepared focused around the frequencies of these gimmick trajectories, from which recognition is performed. This human model, where the subject [side view] is in motion but parallel to the camera was utilized, on the grounds that the walking dynamics happens in the sagittal plane or the plane bisecting the human body.

A new model that uses spectral features of the motion of foot was presented by [12] for gait recognition.It concentrated on utilizing the motion of feet for ID. From the planar projections of the 3D movements of settled focuses at left and right feet, for example, ankles, it removes unearthly gimmicks which speak to the horizontal and vertical progress of a human motion and explore the prejudicial aspects of these signs for particular ID. It likewise considered how these vertical and horizontal developments of the lower legs help in distinguishing the people. This system was profitable, on the grounds that the gimmicks are generally simple to record in a video stream, and not being delicate to the changes in clothing.

Information acquired from two progressive phases of PCA of kinematic data yielded a free spatiotemporal peculiarity for recognition [13]. They discovered that the initial two foremost parts of gait have close correspondence with the identified motion features. In a low dimensional space it has been indicated that PCA could be effectively utilized to represent movement data. Thusly utilization of low-dimensional manifold characterized by the first few essential parts to perform a

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second phase of PCA that depicts deviations in the manifold over people or sorts of strides/gaits. Hence, it primarily distinguishes the temporal characteristics of the motion. Researchers in [14] utilized ellipsoidal fits to human forms. The gait appearance characteristic vector is contained parameters of minute peculiarities in images inferred from silhouettes of a mobile individual collected about whether either by averaging or spectral investigation.

A set of two-dimensional pictures could be utilized as potential feature for recognition extricated along time measurement from picture volume was proposed by [15]. This methodology changes 3D movement of an individual into 2D arrangement of pictures and edges. The vertical cut has one measurement as x-axis against time whereas flat cut has one measurement as y-axis against time. After applying Gaussian derivatives from horizontal and vertical slices, partial derivatives along x (or y) -axis and time axis are obtained. This obtained feature vectors for all the vertical and horizontal slices that are clubbed to form feature vector for the gait, which are later classified using multi-class SVM's (support vector machines).

In order to address the challenges of variation in the viewing angles and huge intra-class variations, [16] proposed a model [robust view transformation] for the purpose of recognition which is based on gait energy images via PCA. The proposed method resulted in satisfactory performance on the multi-view gaits in addition to the wearing or carrying conditions. The proposed method also beats certain methods in terms of the recognition rates. However, further investigation on variability by introducing the effect of noise and the walking speed of different individuals could have been done. Since the said method uses view transformation model, hence the work can be used as the base algorithm for comparing with the proposed method.

The requisition of Hidden Morkov Model (HMM) was proposed by [17] for recognition. The silhouettes were pre-processed with operations to fill the gaps and noisy region removal. The width vector of the external shape was utilized as the picture characteristic. A set of beginning models is built from the gimmick vectors of a step cycle. The inward item separation measures the closeness between the gimmick vector and the model. A HMM is prepared iteratively and after that utilized for recognition. The proposed system lessens picture characteristic from the two-dimensional space to a one-dimensional vector so as to best fit the qualities of 1D HMM.

As per [18], GMM model is introduced to concentrate the silhouettes and remove the background picture from the feature document with the assistance of Gaussian parameters. At that point the peculiarities extricated from the picture casings are anticipated into the Eigen space and the dimensionality decrease is carried out utilizing essential part investigation. MLP classifier joined with PCA gives ideal straight dimensionality decrease lastly brings about negligible procedure time.

The work of [19] perceived that in stride based human ID, numerous variables that decrease the performance, and noise on human shapes are present, on the grounds that to extract forms impeccably is a hard issue particularly in a complex background. The shapes separated from feature arrangements are regularly exposed to noise. To enhance the performance, they needed to diminish the impact of noise. Not same as the strategies, which utilize dynamic time warping to match sequences in time domain, a dynamic time warping based form comparability measure in the spatial space was proposed to lessen the impact of noise.

Using template-matching strategy, an approach for gait recognition during night was proposed by [20]. At first, human recognition was finished, in view of the Gaussian mixture modelling of the background. At that point, human silhouettes were extracted on the basis of preceding detection results. A gait database using infrared at night was manufactured to give an establishment to recognition at night.

In this work, [21] applied an appearance-based walk distinguishment system that focuses on the silhouettes of the subject. Averaged silhouette which is a straightforward stride representation strategy is connected as the step representation procedure. The work registered the eigenvectors of the averaged silhouettes and anticipated them into gimmick space. Euclidean separation is utilized to figure the separation between the anticipated testing specimen and the preparation examines as the distinguishment stage. This technique is executed on typical strolling subjects of the TUM-IITKGP Gait Database.

The work of [22] gives a late extensive overview of just model free walk recognition approach. This overview concentrates on movement free gait picture representation, dimensionality diminishment of separated and extracted peculiarity and characterization. Openly accessible gait dataset are likewise examined. The paper includes the research challenges and by giving future course in model free gait distinguishment approach.

4. A NEW APPROACH TO SOLVE THE PROBLEM

Gait has several essential qualities that make it an exciting applicant as a biometric feature. First, people need not communicate with anything or device in an artificial way. Second, gait unquestioningly takes a living subject test and thus can neither be thieved nor missing [23].

Developing and implementing a gait recognition system is not as easy as it looks from the application point of view. At the root level, it involves complex processing, computations and a number of complexly involved confounding factors which are effectively needed to be addressed in order to develop a complete gait recognition system. A huge number of works done on it from different researchers contribute to enhance the complete package.

As far as our part of work is concerned, the research identifies various human gait recognition algorithms followed by proposing new human gait recognition algorithm taking different viewing angles

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under different scenarios in consideration for calculating the similarity between the silhouettes in order to find the match while implementing it on the publicly available CASIA gait database.

In order to accomplish the objectives of the research work, the following tasks are conducted.

a) This research is started by doing the study literature of various Gait Recognition algorithms. The study covers the basic theories of gait recognition and the existing algorithms which have been implemented, including merits and demerits of the existing implemented system.

b) Define the limitations and variables of the research.

c) Propose a gait recognition algorithm focusing different viewing angles that can be implemented in various platforms.

d) Implementation of the proposed gait recognition algorithm.

e) Evaluating performance and comparing the results of the proposed algorithm to common relevant existing gait recognition algorithms.

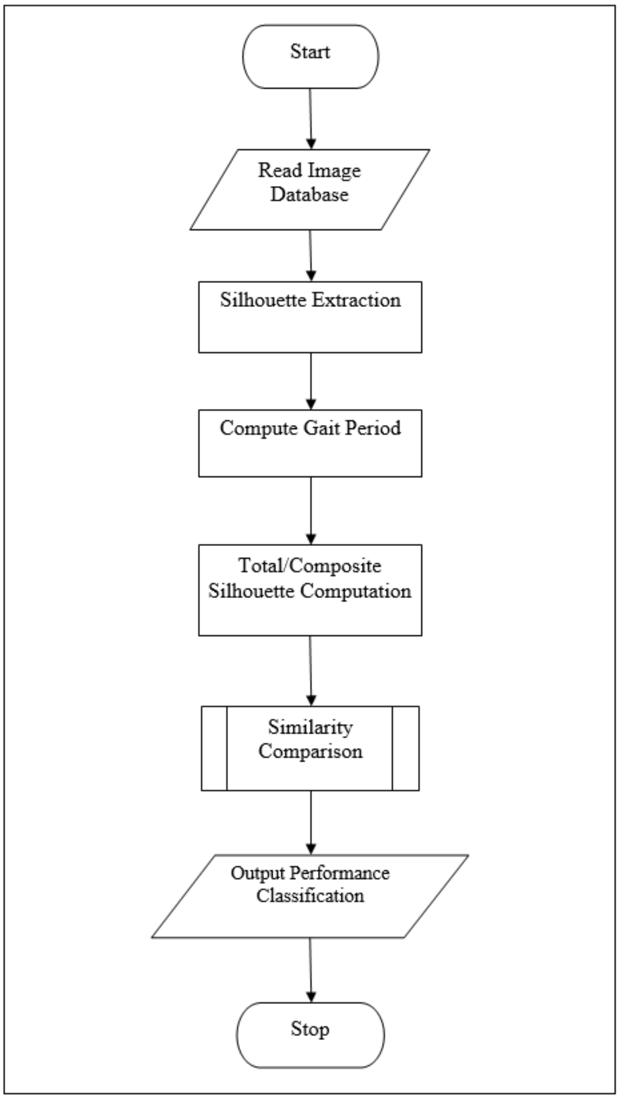

Figure-1. Scheme: gait recognition system.

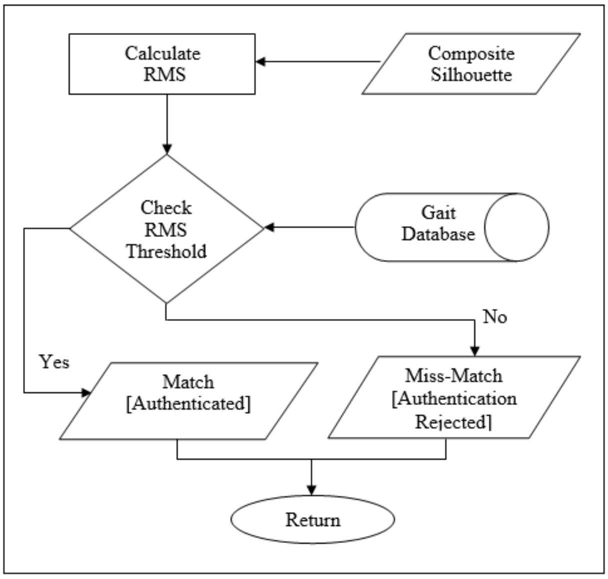

Figure-2. Similarity comparison sub-system.

The process design of gait recognition comprises of a multi staged process. Figure-1 and Figure-2 shows the whole processes of the gait recognition system in this research.

Extraction of the silhouettes

The silhouette is the simplest form of line art and is used in cartoons, technical illustrations, architectural design and medical atlases [24], which is defined to be a region of pixels from a person. Silhouettes are advantageous in realistic rendering, in interactive techniques and in non-photorealistic rendering (NPR). Silhouettes can be extracted from the image frames in many ways. In our case, we don't need to extract silhouettes from the image frames as we are using CASIA gait database as mentioned earlier that provides a wide variety of silhouettes already extracted from the human image database. A few sample silhouettes are shown below in Figure-3.

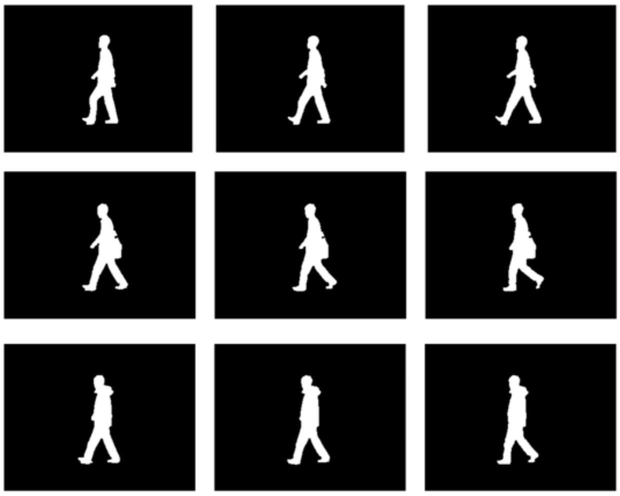

Figure-3. Samples of silhouettes in different scenarios.

Gait period estimation

The next step is to estimate the gait periodicity. The gait cycle explains how does humans stroll and run - in simple words, the gait cycle is how we move. It is the time interval between the exact same repetitive events of walking [25]. Taking the walking pattern in images into account, the amount of pixels in forefront will achieve a most extreme at the full stride stance and minimum at heels together stance. Two sequential strides constitute a stride cycle i.e. from one full stride stance to other full stride stance.

Computation of total silhouette

The third step is total silhouette computation. Total silhouette is obtained by the fusion of all the silhouettes that are extracted in the process of calculating the gait periodicity. This total silhouette representation is obtained by writing a code snippet with the help of Matlab. The representations are then compared with the total silhouette representations of the people already present in the created gallery, in order to find whether there is a match or a mismatch.

Similarity computation

At this stage, the focus is on unique features in extracted silhouette such as the difference between the legs lengths, the symmetry of the body among others in conjunction to what is being used in gait period and averaged silhouette in order to produce a contribution. In our case we are performing the similarity computation by calculating the Root Mean Square RMS values between silhouettes from the probe and the gallery to compare individuals and to check what minimum ratio is required to have a match. The equation to find RMS value between the silhouettes from the probe and the gallery images is given by:

$$RMS = \sqrt{\frac{\sum[I_2(x,y) - I_1(x,y)]^2}{I_1(x,y)}} \quad (1)$$

Where $I_1$and I_2represent the database images and the images from camera that needs to be compared in order to find a match or a mismatch, respectively. Similarity calculations usually tend to obtain the similarities between the probe and the gallery images, but in our case the similarity is achieved by calculating the difference between the probe and the gallery images. Higher the difference, lesser are the similarities and vice-versa.

5. RESULTS OBTAINED

The proposed algorithm was implemented in different scenarios and their recognition rates were correspondingly obtained.

Table-1. Recognition rate.

	Gallery View Angle	54°	72°	90°	108°	126°	144°
SCENARIOS	Probe gait data viewing angle 90° Gallery gait data viewing angle from 54° to 144°	0.89	0.88	-	0.89	0.45	0.22
	Probe gait data viewing angle 126° Gallery gait data viewing angle from 54° to 144°	0.89	0.34	0.89	-	-	0.66
	Probe gait data viewing angle 126° Gallery gait data viewing angle from 72° to 144°(wearing a coat)	-	0.45	0.23	0.45	-	0.89
	Probe gait data viewing angle 90° Gallery gait data under viewing angle from 54° to 144°(with a bag)	0.22	0.23	0.34	0.23	-	0.33

The different scenarios trying to achieve recognition include: when the subjects were walking at different viewing angles from the camera, when subject was wearing a bag again walking at different viewing angles and finally when the subject is wearing a coat and walking under the same circumstances.

Error analysis describes the improvement of proposed algorithm compared to original algorithm based on the recognition error. The recognition error in percentage is simply given by subtracting recognition rate from 100%. Based on the experimentation, out of 45 tests when the probe gait data under viewing angle 90° and the gallery gait data under viewing angle from 54° to 144°, about 30 were the proper matches resulting in 67% of overall recognition and 33% of error. When the same experiment was conducted on people when the probe gait data under view angle 126° and the gallery gait data under viewing angle from 54° to 144°, 25 experiments out of 36 were matches resulting in 31% of failure and 69% of recognition rate. Under the condition that the probe gait data under viewing angle 126° and the gallery gait data under viewing angle from 72° to 144°, out of 36 experiments 18 were matches hence having recognition and error rate of 50% for both. Finally, 23% of recognition is achieved when the probe gait data under viewing angle 90° and the gallery gait data under viewing angle from 54° to 144° was used.

It is also found that the variation in the recognition rates when viewed from the different angles is because of the camera angle with that person. As the measure of the camera angle is increasing or decreasing in comparison to the images of the person, under the recognition, whose images have been taken at a particular angle and stored in the database for the matching process. The recognition rate gradually decreases if we move away from the viewing angle at which the images were actually taken. The rate of recognition is maintained if images taken at particular angle are matched with the images taken at the same or nearby angles.

6. CONCLUSIONS AND FUTURE WORKS

Gait recognition gained popularity because of its ability to perform recognition of individuals at a distance using a video recorder. However, due to the changes in the viewing angles, it gets cumbersome for a system to perform recognition based on the walking pattern of an individual. This work presents an effective but simple method using gait and body silhouettes for the purpose of identification.

This work consists of a baseline method for the purpose of human recognition based on the shape of its body and walking pattern when the subject is observed from different viewing angles. The recognition is tested on the subject in two different scenarios, apart from being observed at different viewing angles. Gait periodicity is estimated after extracting the silhouettes of an individual, followed by obtaining the total silhouette representation of an individual using Matlab. The total silhouette representations obtained from the probe gait data are compared to the gallery gait data representations for the purpose of similarity computation by calculating the RMS value between the said representations. Higher the value, lesser is the similarity & vice versa. The CASIA gait database is use for the purpose of experimentation.

It must be inferred that creating very solid walk based human recognizable frameworks in genuine provisions is, and will keep on being, extremely difficult. The difficulties included in vision-based stride recognition incorporate defective frontal segmentation, variations in viewing angle and clothing, changes in step as a consequence of mood, strolling speed or convey objects, and so on. Rich number of chances and numerous open issues exist and the accompanying issues merit more consideration in future work [5].

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