Biometrics using GAIT analysis

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***Abstract*—Human identification from a distance using the gait patterns has gained a growing interest in the field of biometrics because this an invasive method of human identification, various research has been done on this topic. This paper presents a gait recognition model which recognises the person by the way they walk. The gait parameters considered for recognition are lower body height, step width, cadence. For each image sequence foreground is separated from the background and moving silhouette is extracted. Here we have come up with a new algorithm for gait analysis called structural silhouette and feature extraction(SSFE) . The feed forward back propagation algorithm is used in the process of training our neural network using the extracted features from the silhouette. This paper also explains why SSFE method is more efficient using the results later discussed.**

Keywords- biometrics, gait, SSFE (Structural Silhouette and Feature Extraction) method, BH-Body Height, BW-Body Width, LH-Leg Height, LW-Leg Width, cadence, Feed forward back propagation

I. Introduction

Biometric technology analyzes human characteristics to verify a person using either fingerprints, eyes , face, gait, heart beat , and voice recordings. Gait here is nothing but the walking pattern of the person. Apart from biometrics it can be used for various purposes such as chiropractic and osteopathic. In this paper, it is mainly focused on biometrics usage. Gait when considered for biometrics helps us in the human recognition from far distances under low resolutions and is also a non-invasive method of recognition. Here the walking sequence of the person is fed in as the input the model. Since the walking of the person is periodic in nature, a minimum of one gait sequence is enough for the process of recognition. It is said to be one complete gait cycle when a foot from the front reaches the back and comes back to the front . Many different methods have been proposed over the years in the field of gait recognition[1,2,3,4,5,6,7,9] . In all of these papers silhouette extraction is done using frame subtraction technique. A silhouette is an image of a person in solid colour, mainly preferred in black or white. We have proposed a more efficient method of silhouette extraction in this paper. In this paper we have proposed a new algorithm called the SSFE for more efficient feature extraction and training of the network. The parameters considered in our gait analysis is dynamic base, step length, cadence, stride length, speed[2,5]. Since the gait here is adopted for biometrics, only novel features: body width, leg width(step length), leg length and body length are required[2,5]. This study emphasizes the quantification of these novel features and used for biometrics. The rest of the paper is organised as follows. In section 2 we provide the gist of the related works. Section 3 explains our approach , where the structure of the proposed model is explained. In section 4 we provide the efficiency of our model and discuss our obtained results . In the final section we have drawn up a conclusion about the projects and further developments.

II. Related work

This paper focuses mainly on biometrics of a person using gait, developed on the work of Liu and S. Sarkar in [1]which proposes gait recognition by gait dynamics normalization using a population Hidden Markov model coupled with a Linear Discriminant Analysis based shape space, emphasizing differences in stance shapes between subjects and suppressing differences for the same subject under different conditions. S. Benbakreti and M. Benyettou in [5] proposed a method for gait recognition using leg motion based on fusion of based and holistic body biometrics. This was carried out using Principal Component Analysis P. Nithyakani et al [9]. It is a silhouette based approach as in S. Benbakreti and M. Benyettou[2] Liu and S. Sarkar in[8] L.Wang et al in [9]. The binary matrices are used in mathematical calculation of efficiency as in W. Kusakunniran et all[7]. Feed forward back propagation network has been integrated to reduce the abnormalities in the gait of A. S. M. H. Bari et all[10].

III. Methodology

A. Creation of database for the project

Databases that have been used in the project are our own videos recorded from a 25-megapixel camera having the recording speed of 25 frames per second. The videos that we have recorded considers a particular viewing angle of the subject(camera is placed nearly perpendicular to the side view of the person). Each of these videos is about 5 seconds, thus having a 125 frames per video.

Initial stage where the algorithm had to be developed and a neural network for the proper training of the weights, this was carried out on the basis of trial and error method until properly segmented video was obtained for better feature extraction.

The videos considered in the database have variations in the gait patterns with respect to the subject i.e.speed, arm-swing, step width. These variations were considered because of the changes in surroundings of the subject at a particular time.

A wide range of variations are considered and almost 35 videos of each subject i.e.a total of 105 videos has been used to train the Neural network. Features from about 9375 frames has been extracted. These videos cover almost all types of gait, including Slow steps, Fast steps, Broad steps, Tapered steps and so on.

B. Silhouette extraction

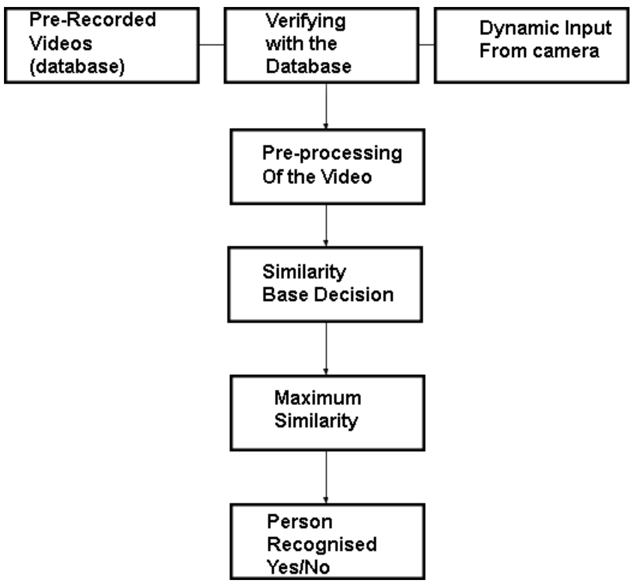

Fig. 1. Block Diagram

A series of images of the walking sequence of the person is fed in as the input. Silhouettes are then extracted from the input. These silhouettes are cleaned and fine tuned for better feature extraction. To clean our silhouette resizing of each frame will be done, Median Filtering will be applied to take out the small objects in each frame, Histogram equalization will be done to the obtained median filtered frames, Conversion of RBG to gray-scale will be done, Gaussian filtering will be done on the Gray scale frames. From this, the Gray scale image will be converted into binary image. To normalize the obtained image and further reduce the small object variations in the each frame. Morphological operations of disks and rectangle have been used on the frames. It has been shown in the fig 4. .To verify and compare the silhouette extracted from SSFE method, we have considered mean, Standard Deviation, Variance, Root mean Square, Kurtosis and Sknewness inorder to show the betterness of our method.

C. Accuracy checking of silhouettes

Since we have compared two methods 1)Frame difference method 2)SSFE method for silhouette extraction . Accuracy for both of these methods has been done: .

Since the output observed from the frame difference method is insufficient for the feature extraction, SSFE method was proposed .

TABLE I
EFFICIENCY OF THE SILHOUETTE EXTRACTED FROM BOTH THE METHOD

Methods	Mean	Standard Deviation	Entropy
Frame Difference	0.221	0.431	0.236
SSFE	0.753	0.346	0.236

D. Features Extracted for Biometrics

Biometrics need parameters to compare the obtained image or data to verify the person. Since we are not merely matching the obtained image matrix to the database created, we are extracting features such as [2] [5] [9]

- BH - 60% of the total height of a person.
- BW - The arm swing of the person.
- LW - The Leg swing of the person.
- LH - 40% of the total height of a person.
- Cadence - Speed of a person.

The image representation of the following has been given in the below figure.

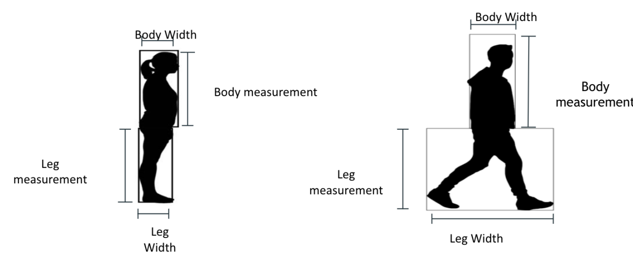

Fig. 2. Example of how the feature is extracted

The obtained features from each video is then given to a neural network for absorption of the irregularities.

E. Neural Network training

Once the required features are extracted from the silhouette, they are fed in as the input for neural network for training. A simple neural network has a input layers, hidden layers and output layers. Each hidden layer is trained by the network having weights have bias function.After the output is specified in the output layer, the network trains itself by adjusting the weights till the error becomes the least. The features we have considered for the biometrics may vary depending on the instance of time. A person's gait may vary depending on the surrounding environment. Given such variations, the model must be able to reduce the error i.e. the change in the gait pattern of a person and make a better prediction with the available feature data. Hence to consider these small variations and to improvise the recognition rate, we have induced a neural network to train a particular gait pattern of the person. We have used a feed forward backpropagation neural network in the project. The mean of the extracted features of all the frames of a video is fed as the input to the neural network. This is carried out for all the videos in the dataset and mean of the

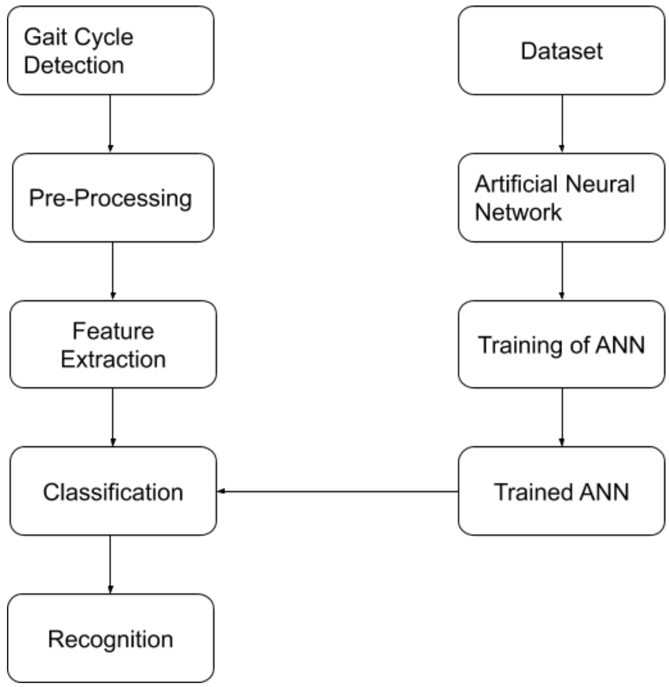

Fig. 3. Block diagram of neural network

of the output obtained is assigned as a particular target. The number of hidden layer used in the process of training is 14. This can be varied depending on the GPU of the system used. The backpropagation algorithm used here helps in the process of reducing the error at the output by altering the weights and thus enhancing the recognition rate of our model.

IV. Results and Discussions

The results of the silhouette obtained from our proposed algorithm are shown in Fig.4, Fig.5, Fig.6. Efficiency of our method over the frame difference has been mentioned below. How the consideration of our network is making our model more aggressive compared to template matching has been shown in TABLE 3. Since we get an overall efficiency of 80% from this model, this method can be considered as one of the accurate gait recognition technique.

Fig 4, Fig 5 and Fig 6 displays the output silhouette obtained from SSFE

75 videos have been used for training of neural network and 30 videos have been used for testing(25 videos for training and 10 for testing per subject).

TABLE II
Accuracy in SSFE with and without Neural Network

Tested for 3 Subjects with 10 videos of each	Frame difference	SSFE
Accuracy	37.03%	80.00%

V. Conclusion

In this paper, we proposed a SSFE model approach for the gait analysis. And further, how usage of Neural Network is

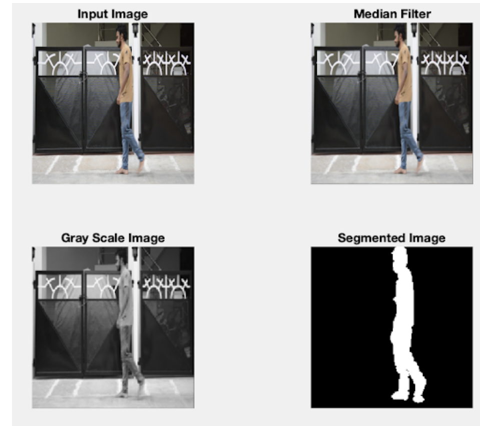

Fig. 4. Visual output obtained from SSFE method of person 1

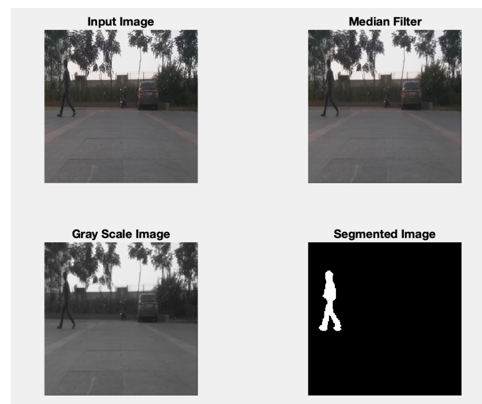

Fig. 5. Visual output obtained from SSFE method of person 2

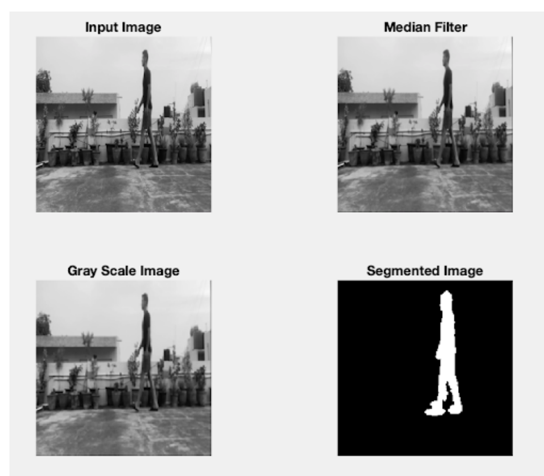

Fig. 6. Visual output obtained from SSFE method of person 3

TABLE III
Accuracy in SSFE with and without Neural Network

Tested for 3 Subjects with 5 videos of each	Without Neural network	With neural network
Accuracy in	55.55%	80.00%

increasing the efficiency in gait recognition. As future work, Gaussian filtering has the limitation of image sizing. It cannot be used on large images (pixel wise). Hence resizing of the image is done, which causes the loss of data.

Further development can be done on non-static cameras, where the subject and camera, both are moving.

A complete gait is required for the analysis in the project. If a complete gait is not recorded, then the biometric fails to recognise a person. So further development can be done on Gait recognition for incomplete gait cycle information.

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