COMPARISON OF GAIT-FACE FUSED HUMAN RECOGNITION TECHNIQUES

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Abstract— In this paper we have proposed two different techniques for developing a reliable Human Recognition System. The model is developed with the help of real time Open CV and Emgu CV library. In our approach we have made use of two different techniques i.e., Model Based Technique and Holistic Based Technique for extracting two different sets of features. Model Based Technique is used for extracting certain geometric distances related to static and dynamic features from the Face and Gait Biometrics. Holistic based Technique is used for extracting certain statistical features related to the whole image of the person. Finally the feature sets obtained for Face and Gait are fused together using three alternative classification techniques (Bayes / Artificial Neural Networks / Support Vector Machines) and the relative accuracy of these two techniques is tested. Once recognition is done, automatically attendance will be updated in an Excel Sheet along with his photo, name, date and time. Our system can automatically update the Database for the newly enrolled persons. Since gait is captured from a distance, for the convenience of the user we have integrated hand gesture recognition to our system, with the help of which we can use our hand as a virtual mouse and control the GUI from larger distances. We have an another option of controlling the GUI by giving voice instructions to it (eliminating the need of a mouse interface) and our system can speak back to us.

Keywords— Face, Gait, GEI. Kinect

I. INTRODUCTION

Human Identification and Recognition system is one of the emerging research fields in Computer Vision. The recent terrorist attacks have shown that it is indispensable to have an automated video surveillance system for protecting people and assets in public civilian places. The other major application for Human Recognition is for Automated Employee/Student attendance system.

In this paper, we have proposed two different methods for recognising a Human, in which some Holistic statistical features and Model based Geometrical features are extracted from face and gait biometrics.

The rest of the paper is organized as follows: The detailed literature survey is given in section II, the proposed model is explained in section III, the experimental results are shown in section IV, and finally conclusion and future scope are discussed in section V.

II. LITERATURE SURVEY

The research going on in Person Recognition using different Biometrics such as face, Gait, Height etc. are discussed in the following sub-sections.

A. Face Recognition

Face recognition can be done in two ways, Holistic based and Feature based. For holistic method we will take the whole image and will proceed further for recognition as in PCA, LDA, ICA etc. For feature based method, certain features such as eyes, nose etc are located on face, and based upon which facial recognition takes place.

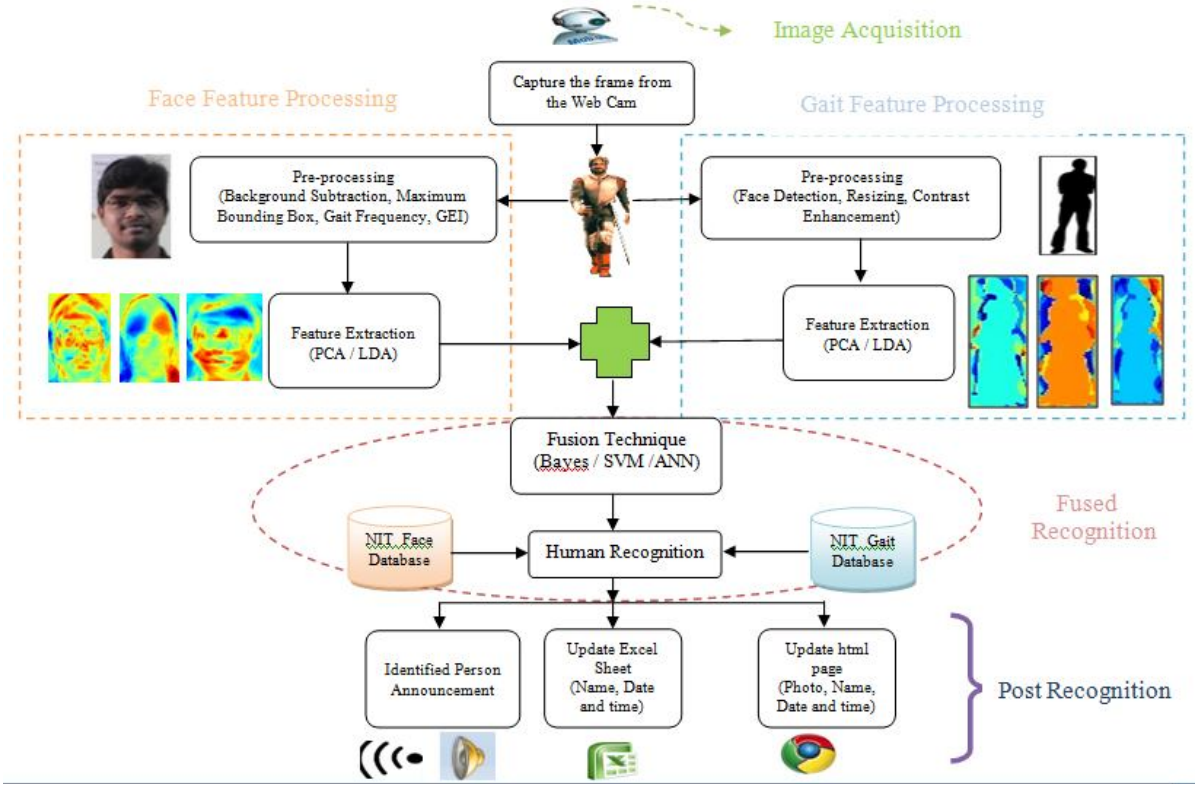
Some of the Holistic based methods are as follows: We can use PCA (Principal Component Analysis), where the face images are projected onto a lower dimensional subspace [1]. The Eigen vectors are chosen in the direction of maximum variance.ICA (Independent Component Analysis) is another technique, in which it tries to minimize both second order and higher order dependency of the data [2]. Another technique is LDA (Linear Discriminate Analysis), in which we try to minimize the within class variance and maximize the inter class variance.

B. Gait Recognition

Person Recognition system using Gait as a biometric uses two different methodologies like Model based and Holistic based. Model based method assumes a model for a person and based upon which calculates static body measurements [3], features extracted by elliptical model fitting [4][5] and dynamic features such as stride length and hip angle periodicity [6]. Holistic based method doesn't assume any model for a person; instead they take features from the whole image. Optical flow method is used for Gait Recognition [7]. Gait Energy images are used for Gait Recognition [8]. The width of the silhouettes is taken and periodicity present in the width is investigated [9].

III. PROPOSED MODEL

The proposed model for Holistic Based and Model Based Human Recognition System are as shown in the below sub-sections.



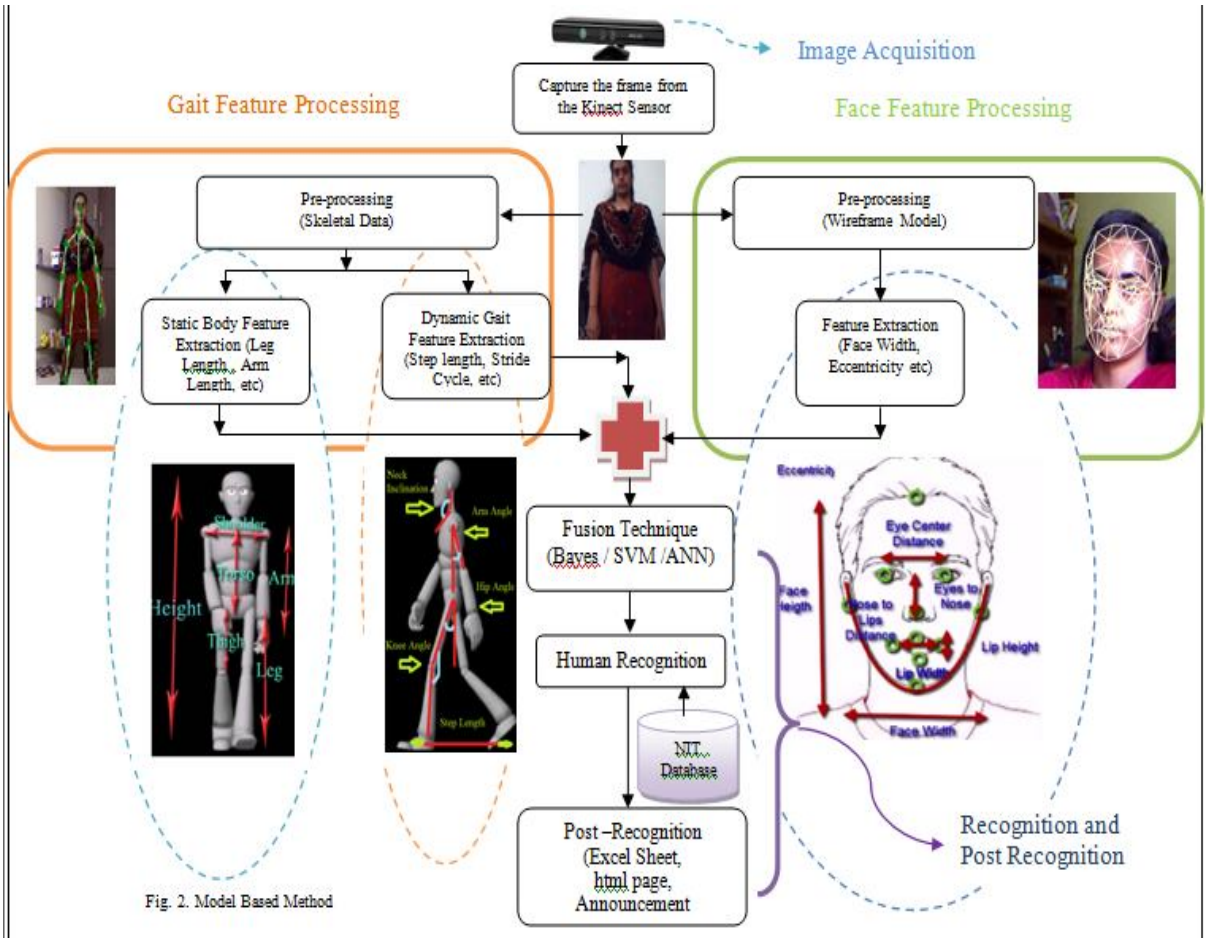


Fig. 2. Model Based Method

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A. *Holistic Based Method:*

The proposed model for Holistic Based Human Recognition System is as shown in Fig. 1.

The main modules used are

1) *Pre-processing:*

a) Face : Viola–Jones face detection algorithm is used for Face detection. Once face is detected, it is resized to 92 *112 pixel resolution. We have used Min-Max Linear Contrast Stretch Enhancement Technique, which linearly expands the initial distribution of an image to a new distribution.

b) *Gait:* Gaussian Mixture Model is used for background subtraction and then the Silluotte is extracted. Then Morphological operations like erosion, dilation and contour component labelling is used to extract the exact contour of the Silluotte. Then Maximum Bounding Rectangle is fitted to the largest area Silluotte. Based on the periodicity present in the width of the Siluotte, autocorrelation is used for extracting the Gait frequency. Based on this Gait frequency, Gait energy Images (GEI) are computed for each person.

2) *Feature Extraction:*

The GEI obtained from Gait subsystem and the detected - resized – contrast enhanced face obtained from Face subsystem are individually projected onto lower subpace using PCA/LDA.The individual weight vectors obtained here acts as Face and Gait Feature Vector.

3) *Holistic Based Gait-Face Fusion:*

The weight vectors obtained from Face and Gait Recognition System are fused together for improved accuracy. The different classifiers used are: Bayes Classifier / Artificial Neural Networks (ANN) / Support Vector Machines (SVM).

B. *Model Based Method:* The proposed model for Model Based Person Recognition System is as shown in Fig 5.

The main modules used are:

1) *Skeletal Data Extraction*

Kinect SDK (Software Development Kit) provides skeletal tracking of two people standing in front of the sensor. The skeletal tracking gives information about 19 bones and 20 joints. The information returned by the Kinect sensor is regarding the 3D location of the joints i.e., X, Y and Z co-ordinates.

2) *Face Tracking System*

The Microsoft Face Tracking SDK along with the Kinect SDK enables us to create applications which can track faces in real time .It returns the co-ordinates of 121 different points on the face.

2) *Feature Extraction*

a) Facial Features : The following are geometrical distances obtained between the different points on the face: Eye Centre Distance, Eccentricity of face, Eyes to nose distance, Lips to Nose distance, Lips Height, Lips Width, Height of face and Face Width

b) Gait Features: The following feature vectors are extracted from the skeleton tracked.

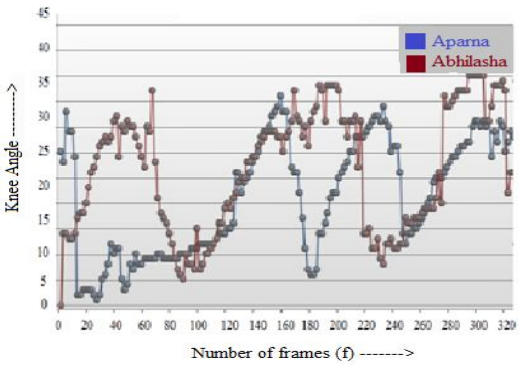
- Static Parameters: Height, Torso Length, Shoulder Length, Right and Left Arm Length, Right and Left Forearm Length , Right and Left Leg length, Thigh length, Neck Length
- Dynamic Parameters: Left and Right Stride Length, Stride Cycle, Neck Inclination, Periodicity in Height of person, Velocity, Periodicity, Maximum / Minimum values and Angular Velocity of Knee angle.

4) Feature Recognition: The above extracted features are recognized using Bayes Classifier /SVM /ANN.

IV. EXPERIMENTAL RESULTS

1) *NIT Database:* It is the Face and Gait database collected from 40 students of NIT Warangal.

Angle Kinematics: Figure 3 (a) shows variations in the knee angle. Hence from the angle variations, we can observe that there is some periodicity present in the person's gait, which is found from the auto-correlation function as shown in Fig. 3 (b).



(a)

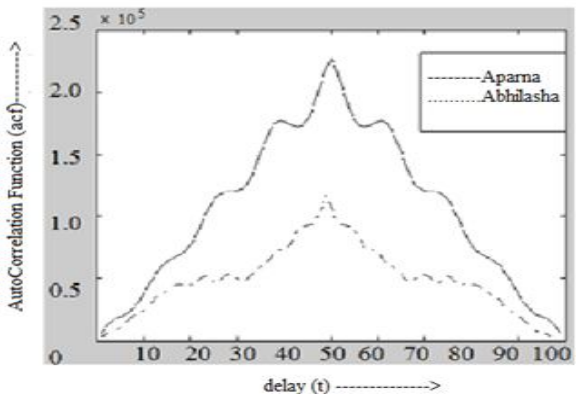


Fig.3 (a) Knee Angle Variations (b) Autocorrelation

3) Graphical User Interface (GUI):

Figure 7 shows the Holistic based GUI that was made using Microsoft Visual Studio 2010, as a Windows Forms Application using Visual C++ as a programming language and making use of OpenCV 2.4.2 (computer vision library written in c++) and together with some add on visual effects in the GUI . Figure 4-6 shows the Model Based GUI that was made using Microsoft Visual Studio 2010, as a Windows Presentation Foundation (WPF) Application using Visual C# as a programming language and making use of EmguCV 2.4.9 (c# wrapper for OpenCV) and together with some extra visual effects in the GUI such as green screen, virtual mouse, virtual keyboard, animations etc.

Fig.4 GUI: Start up page

Fig.5 GUI: Face Recognition System

4) ANALYSIS:

Table I shows the experimental results obtained while comparing the accuracy of Holistic Based Technique while Table II gives the results obtained for Model Based Technique. Table III shows the comparison between Holistic Based Method and Model Based Method for certain special cases.

Table I
Holistic Based Method

Recognition Methodology	Recognition Accuracy
Face Recognition	90%
Gait Recognition	85%
Face + Gait Recognition	95%

Table II
Model Based Method

Recognition Methodology	Recognition Accuracy
Face Recognition	92%
Gait Recognition	89%
Face + Gait Recognition	96%

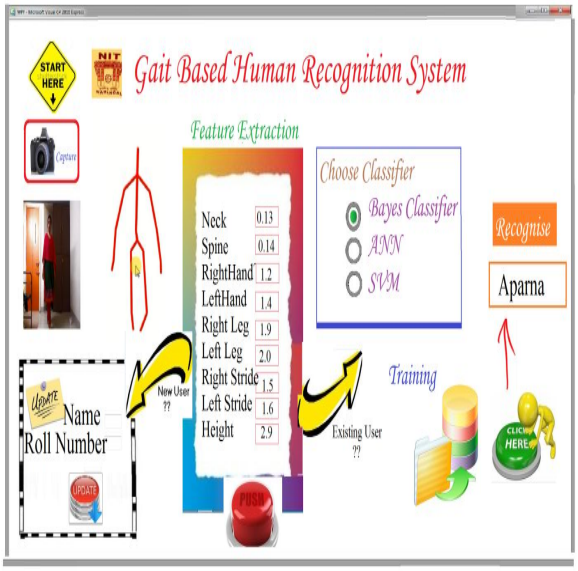


Fig.6 GUI: Gait recognition System

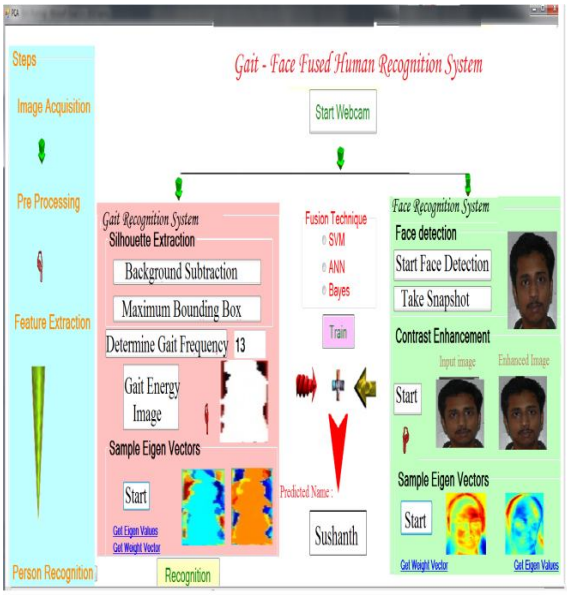


Fig. 7. GUI: developed Face – Gait fused Recognition System

Table III
Comparison of Model and Holistic Methods for Special Cases

Special Cases	Holistic Based Methodology	Model Based Methodology
Spectacles (Face Recognition)	75%	90%
Face Scarf (Face Recognition)	7 %	9%
Tonsuring Head (Face Recognition)	70 %	91%
Pregnant Women (Gait Recognition)	5%	89%
Clothing Variations (Gait Recognition)	65%	89%
Flooring Conditions / Injury (Gait Recognition)	60 %	82%
Distance Variations (Gait Recognition)	60%	88%

CONCLUSION AND FUTURE SCOPE

Due to the mounting demands for Visual Surveillance, person recognition systems have gained a lot of importance these days. Gait is found to be one of the good biometric for medium to longer distance and face, another good biometric for shorter distance recognition. Hence in this paper we have proposed a Holistic Based (Model-free) Gait-Face Fused Recognition System. We have examined 2 different techniques and found that Model Based Technique gives better accuracy when compared to Holistic Based Technique. We have also found that accuracy obtained by fusing gait and face is more when compared to individual face and Gait biometrics.

Performance reduces when both the Face and Gait Features are not available. If either of them is available, our system works. Typical simultaneous variations where our system is likely to fail are intentional variations in the gait/clothing and intentional masking of the face /tonsuring of the head /beard/obscuring the face with a scarf.
Problem with using gait as a biometric is, we can't tell always that a person walks, sometimes he may bend /sit / or perform some other activity. In such cases, we can't recognize a person based on gait. Hence we can further improve our method, by recognizing a person based on the way he performs some action (run, jump, sit, bend etc.).Disadvantage of using a Kinect Sensor is, it can detect 4 people and track only 2 people. Hence we can't recognize more than 2 people at a time, which is to be further investigated. One of the problems when using Model based method is self occlusion of a person while walking leads to erroneous features .Hence in order to avoid this problem we can go for Holistic methods, but they are highly dependent on viewpoint. Hence in order to get better accuracy we can fuse these two contradicting techniques to achieve view, scale invariant and also free from self occlusions. In addition to the above challenges, further methods have to be researched in recognizing a person from his back view.

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