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Gait Recognition of a Person to Detect Flat Foot Problem

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ABSTRACT
Biometrics is used in a wide array of applications, which makes a precise definition difficult to establish. The most general definition of a biometric is: "A physiological or behavioral 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's identity.Using gait as a biometric is a relatively new area of study, within the realms of computer vision. In this paper Gait recognition is done in order to detect flat foot problems in an individual.

General Terms
Biometric Pattern Recognition, Gait recognition, Image Processing.

Keywords
Gait recognition, Genetic Algorithm, Segmentation

1. INTRODUCTION
1.1 Biometrics
Biometric is: "A physiological or behavioral 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's identity. They can be classified into two distinct categories-
Physiological which are derived from a direct measurement of a part of a human body. The most prominent and successful of these types of measures to date are fingerprints, face recognition, iris-scans and hand scans and the second category is Behavioral which extracts characteristics based on an action performed by an individual, they are an indirect measure of the characteristic of the human form.Jain *et al* [1], describes the definition of biometric as the task of biometric (from Greek bios-life, metron-measure) systems consists of determining the individual identity founded on his or her differentiating physiological and/or behavioral features in the majority of cases both properties are addressed.The main feature of a behavioral 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. With a biometric a unique signature for an individual does not exist, each time the data from an individual is acquired it will generate a slightly different signature, there is simply no such thing as a 100% match. This does not mean that the systems are inherently insecure, as very high rates of recognition have been achieved. The recognition is done througha processof correlation and thresholding.

1.2 Gait Recognition
Gait recognition is the process in which an individual's foot abnormalities can be identified by the manner in which they walk. Gait Analysis comes under a Biometrical study, which is a very important research problem with respect to security and recognition of medical problem for diagnosis. This is a marker less unobtrusive biometric, which offers the possibility to identify people at a distance, without any interaction or co-operation from the subject (no physical contact is required), this is the property which makes it so attractive as a method of identification. Gait is also one of the few biometrics that can be measured at a distance, which makes it useful in surveillance applications as well.

1.3 Gait Cycle

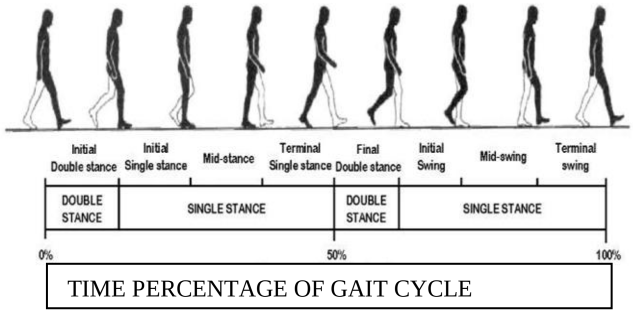


Fig 1: Gait cycle

The Gait cycle comprises of two basic stages; these are Stance stage and Swing stage. The stance begins with the heel of the forward limb making contact with the ground and ends with the toe of the same limb leaving the ground. In the swing stage the foot is no longer in contact with the ground. During the swingstage the body weight is totally transferred and no portion of the leg is touching the ground surface. A Gait cycle is the time interval between successive instances of initial foot-to-floor contact 'heal strike' for the same foot. Each leg has two distinct periods as explained above; the stance phase and the swing phase.

There have been various works and researches carried out in the field of Gait recognition and analysis.According to the works carried out by Mrs.D.Sharmila and Dr.E.Kirubakaran[2], they used two methods, firstly Image based gait recognition(spatio temporal sequence of images) and secondly, gait recognition using formulas i.e.(cadence, stride length, height and vertical displacement).Matlab software is used for image processing in this technique and in case of formula consists of computing mid- feet point, estimating period of gait, estimating 3D trajectory, estimating stride and height parameters.Dr.A.Venkataramana [3] *et al* makes use of Discrete Cosine Transformation, Radon transform and PCA based method for better results. Gait recognition method using DCT, Randon Transform and PCA is proposed in this paper.

DCT captures the features of an image by reducing the redundant information present in the image. Radon Transform provides mapping from Cartesian co-ordinates to polar co-ordinates. Finally PCA was applied on the DCT and Radon transformed image to reduce the dimensionality. The use of DCT and Radon Transform provides better representation of the given silhouette sequences. From the simulation results it is observed that the recognition rate is higher. Further work in this direction will be to identify algorithm for faster computation. Further the same experiment is to be repeated by taking real time gait images.Ju Han[4] *et al* proposes a new spatio-temporal gait representation, called the Gait Energy Image (GEI), for individual recognition by gait. Unlike other gait representations which consider gait as a sequence of templates (poses), GEI represents human motion sequence in a single image while preserving temporal information. To overcome the limitation of training templates, they propose a simple model for simulating distortion in synthetic templates and a statistical gait feature fusion approach for human recognition by gait. This paper presents a systematic and comprehensive gait recognition approach, which can work just as fine as other complex published techniques in terms of effectiveness of performance while providing all the advantages associated with the computational efficiency for real-world applications.Huma Khan and Yogesh Rathod[5] proposes a system in which works with the assumption that the video sequence to be processed is captured by a static camera, and the only moving object in video sequence is the subject (person). Given a video sequence from a static camera, this module detects and tracks the moving silhouettes. This process comprises of two sub modules; Foreground Modeling and Human tracking using skeletonization operation.Qiong Cheng[6] *et al* proposes a new gait recognition method using Principal Component Analysis (PCA) and Linear Discriminant Analysis (LDA). PCA is first applied to1D time-varying distance signals derived from a sequence of silhouette imagesto reduce its dimensionality. Then, LDA is performed to optimize the pattern classification and Spatiotemporal Correlation (STC) and Normalized Euclidean Distance (NED) are respectively used to measure the two different sequences and K nearest neighbor classification (KNN) is finally performed for recognition. The experimental results show the PCA and LDA based gait recognition technique is better than that based on PCA.According to Ben-Abdelkader *et al* [7] the interpretation of human gait is the synchronized, integrated movements of hundreds of muscles and joints in the body. All humans follow the same basic walking pattern, but their gaits are influenced by functions of their entire musculo-skeletal structure . Limb length, body mass, stride length and several other factors affect the walking of a person.Many researchers from engineering field till 1970 have not carried out the work for Gait analysis. In the year 1980, Nasher [8] further continued the concepts made in previous works done by Harris and Beath [9].He carried out the work in detecting the problems while walking for the cardiac patients.The errors have been investigated in the work done by Nasher[10].Later ,Garrett andLuckwill [11] carried the work for maintaining the speech of walking through EMG and Gait analysis.

2. METHODOLOGY

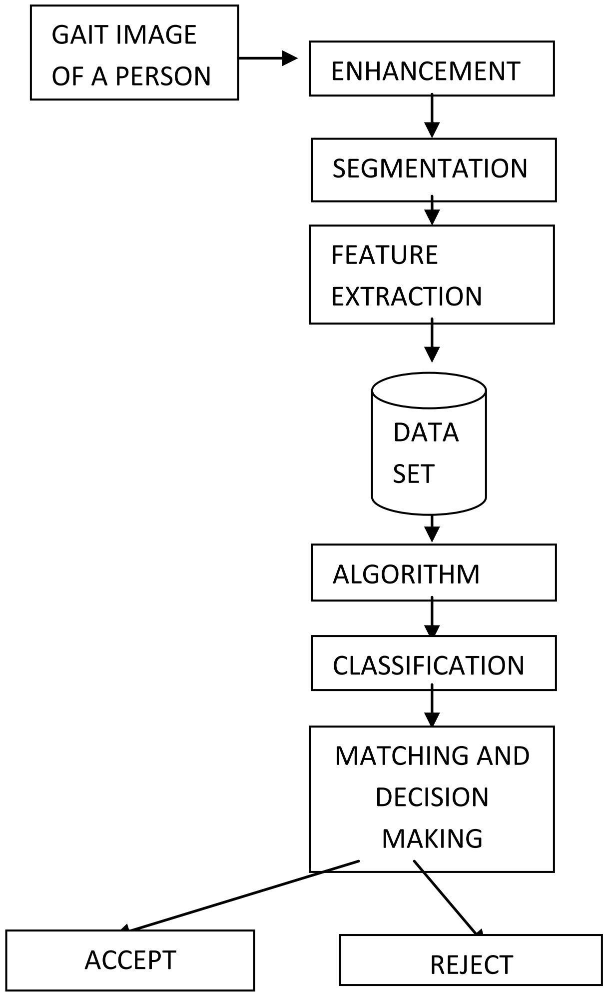


Fig 2: Flowchart of method used

2.1 MATHEMATICAL ANALYSIS

Based on the assumption that the original image is additive with noise. To compute the approximate shape of the wavelet (i.e., any real valued function of time possessing some structure), in a noisy image and also to estimate its time of occurrence, two methods are available, first one is a simple structural analysis and the second one is the template matching technique.
For the detection of wavelets in noisy image,
assume a class of wavelets, Si(t), I = 0.... N-1, all having some common structure. Based on this assumption that noise is additive, then the corrupted image has been modeled by the equation -:

$$X(m, n) = i(m, n) + Gd(m, n) \quad (1.1)$$

where ,
i(m,n) is the clean image, d(m,n) is the noise and G is the term for signal-to-noise ratio control.
To de-noise this image, wavelet transform has been applied. Let the mother wavelet or basic wavelet be y(t), which yields to,

$$\omega(t) = \exp\,(j2\pi ft - t^2/2) \quad (1.2)$$

Further as per the definition of Continuous Wavelet transform CWVT (a,ti), the relation yields to,

$$\text{CWVT}\,(a, \tau) = (1/\sqrt{a}\,)\int x\,(t)\,\omega\,\{(t-\tau)/a\}\,dt \quad (1.3)$$

The parameters obtained in equation (1.3) has been discretized, using Discrete Parameter Wavelet transform, Thus equation (4.3) in discrete form results to equation (1.4),

$$\mathrm{DPWT}\,(m, n) = 2^{-m/n} \sum_k \sum_l x(k, l)\, \omega(2^{-m}k - n) \quad (1.4)$$

where `m' and `n' are the integers, ao and τo are the sampling intervals for `a' and `i', x(k,l) is the enhanced image. The wavelet coefficient has been computed from equation (1.4) by substituting ao = 2 and τ0= 1.

Data compression has been performed by using Discrete cosine transform(DCT)

$$DCT(u, v) = \sum_{m=0}^{M-1} \sum_{n=0}^{N-1} I(m, n) \cos\left(\frac{2\pi T(m+n)}{MN}\right) \qquad (1.5)$$

Principal component is computed using covariance method:

$$Cov(X, Y) = \frac{\sum_{i=1}^{n}(Xi - X')(Yi - Y')}{N-1} \qquad (1.6)$$

Where, X and Y are data sets; X' and Y' are mean

Eigen vectors and Eigen values of covariance matrix are calculated. Segmentation of image is done using connected component method

2.2 ALGORITHM

STEP-1 Read the number Gait frames that are unknown.
STEP-2 Set frame counter, fcount=1.
STEP-3 Do while fcount <= NF
STEP-4 Read the gait image[fcount]
STEP-5 Enhance the image for proper view
STEP-6 Apply techniqueof lossless Compression
STEP-7 Compute the connected components for segmenting the image
STEP-8 Crop the image for locating the Region of Interest
STEP-9 Compute the Walking Speed step length, (Kneeto Ankle)distance, Angle of foot and Shank width
STEP-10 Compute the genetic parameters using the relation as,
UB=(((mmax-mmean)/2)*A)+mmean
LB=(((mmean-mmin)/2) *A)+mmin
where `A' is the pre-emphasis coefficient, mmax is the max value and mmean is mean value and mmin is minimum valueUB is upper bound and LB is lower bound value.
STEP-10 Store the features.
STEP-11 Perform best fit matching.
STEP-12 Perform classification and make decision.
STEP-13 End do.
STEP-14 Display result .

3. DISCUSSIONS

In this paper I have used two phases – Training phase and Recognition phase. In the Training phase a knowledge-based data set has to be formed using Artificial Neural Network (ANN). In the Recognition phase, this model will be used for understanding of an unknown Gait for Gait analysis. The Enhancement phase has been used to obtain the distortion free and compressed image for further processing. The noise free image has been obtained by using filters. The compression of the noise free image has been obtained by using some compression techniques such that the information should notbe lost. In this present work the DiscreteCosine Transform (DCT) [7]has been used to compress the noise free image. After obtaining the compressed image the various parameters have been extracted that is required for the present work. The output of the enhancement phase that is the compressed image has been provided to the segmentation phase. By using segmentation methods the various parameters such as lines and points of the image has been detected. The next step in formation of the Gait Model (knowledge-based model) is Feature Selection and Extraction. The expected result is to develop an algorithm that will calculate basic features in human walking and match it with the results in the database and help us in recognition of Gait of the person.

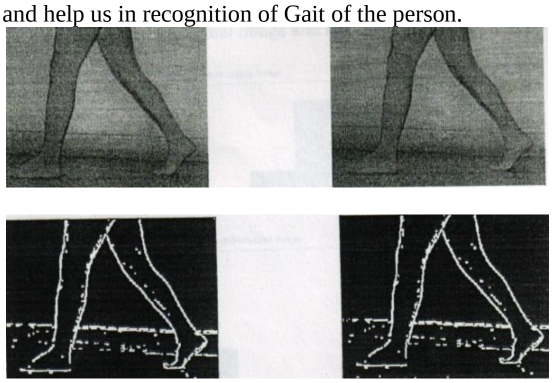


Fig 3: Figure showing original, enhanced and segmented images.

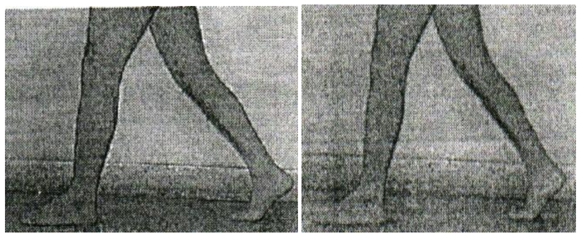


Fig 4: Figure showing original and sharpened image

3.1 REGION OF INTEREST

Region of interest is that area of images which are useful in analysis of Gait. The entire original image is not used for analysis,only the region of interest is used for analysis.

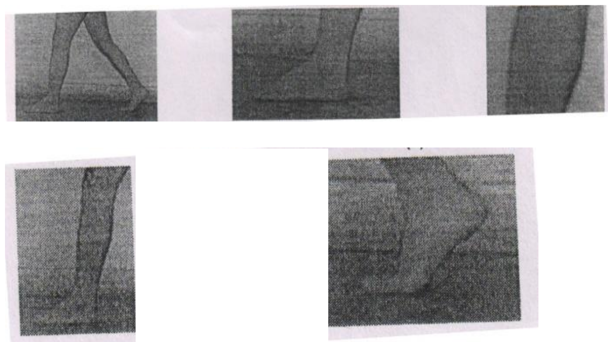
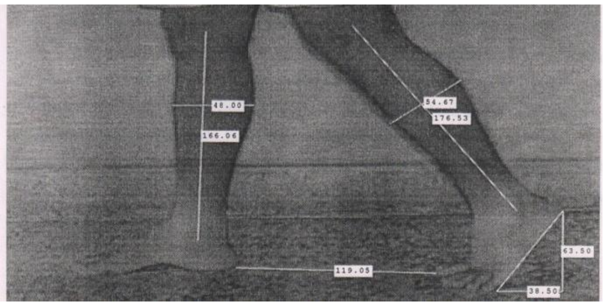


Fig 5: Figure showing region of interest for gait analysis.

The above shown figures show he area of interest to detect foot problems of a person using his Gait. Thus from above it is clear that the original images obtained has to be cropped in order to get the region of interest. Thus the obtained original images are cropped according the area of interest.

3.2 GEOMETRICAL FEATURE CALCULATION

Various geometric features of the region of interest are calculated which is helpful in analyzing the persons gait .The images shown below shows the geometric feature extraction from the images obtained.



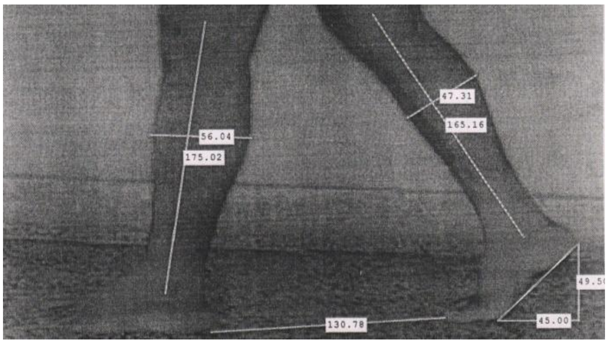


Fig 6: Figure showing two frames for geometric calculation of features of region of interest.

4. OBSERVATIONS

Observations are drawn out using the geometrical features that are extracted from the above image.

Table 1. Geometric features of Gait image

Image	Gait	Foot angle in degrees	Step Length in pixels	Foot Length in pixel
Img1	Standing	0	0	105
Img2	Walking(Left leg)	61.5	122.5	102
Img3	Walking(Right leg)	46	119.4	103
Img4	Walking(Left leg)	57.4	118	101
Img5	Walking(Right leg)	47	129.8	103

The above shown table shows the values of various geometric features that are extracted from the region of interest.

Table 2. Extracted parameters

Image	Gait	LB	UB	Eigen value	Eigen Vector
Img1	Standing	-269.412	2620.24	130.115	0.0016273
Img2	Walking(Left leg)	-290.525	2637.19	69.34	0.0019628
Img3	Walking(Right leg)	-430.764	2548.69	62.8651	0.0001926
Img4	Walking(Left leg)	-412.331	2658.6	64.6354	0.0003645
Img5	Walking(Right leg)	-365.698	2650.6	64.5754	0.0007164

The above calculated values are stored in the database and then same values are calculated for unknown person and matching is performed using algorithms. Matching is done and thus foot abnormality is found out.

5. CONCLUSION AND FUTURE SCOPE

The present work has been done in order to detect foot abnormalities in a person by storing his gait features. The work can be extended further for motion images(video).Work can also be extended for a person who is carrying some weight also. Other environments such as rough surface, slippery surface etc. so on has to be considered for further study.

6. REFERENCES

[1] A. K. Jain, L. Hong and S. Pankanti., " Biometric identification," Commun. ACM, vol. 43, no. 2, pp. 90-98, 2000.

[2] Mrs.D.Sharmila MCA,Mphil,Dr.E.Kirubakaran,Member, IACSIT: Image and Formula Based Gait Recognition Methods Vol.2,No 2,April 2010

[3] Dr.A.Venkataramana, B.Krishna, B.Saideep, B.Sai Kumar:CombinedDCT, Radon Transform and 2DPCA Based Approach for Gait Recognition,Vol 3(2)

[4] Ju Han, Student Member, IEEE, and Bir Bhanu, Fellow, IEEE: Individual Recognition UsingGait Energy Image,Vol.28,February 2006

[5] Huma Khan and Yogesh Rathod:An Efficient Gait Recognition Approach for HumanIdentification Vol.2(1),Februray 2010

[6] Qiong Cheng , Bo Fu , and Hui Chen School of Electrical & Electronic Engineering, HubeiUniversity of Technology:Gait Recognition Based on PCA and LDA,December 2009

[7] Ben-Abdelkader C.,Cutler R., and Davis L.,"Gait Recognition using Image self-similarity",EURASIP Journal on Applied Signal Processing, Vol. 4

[8] Nasher L.M., "Balance adjustments of humans perturbed while walking",Journal of Neurophysiology, Vol.44

[9] Harris and Berth,"Etiology of Personal spatic Flat foot", The journal of joint and bone surgery,Vol.30B No.4

[10] Garrett M. and Luckwill E.G.,"Role of reflex responses of knee musculature during the swing phase of walking in a man", Eur J Appl Physiol Vol.52,No.1,pp 36-41, 1983

[11] Ahmed N., Natarajan T., and Rao K.R., "Image processing and Discrete cosine transform",IEEE transaction on Computers,Vol.C-23,pp 90-93,1974.

[12] James.E.Cutting and Lynn T. Kozlowski,"Recognizing friends by their walk:Gait perception without familiarity cues",Bulletin of the Psychometric Society 1977,Vol 9(5),353-356