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RESEARCH ARTICLE

Foot Features Extraction Based Shape Geometry

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*Abstract— **In this paper we try to achieve that the foot geometry technology based on the fact that every person has a special foot shape. This present a new approach for extraction features from human foot based on shape geometry of its boundary frame by extracting 16 geometric features from a human foot .determine the foot center, and Then we calculated the distance between the center and outer point by different angles were measured .the angles are from 0˚ to 330˚ by increment with 30˚ gradual. The data base was created in our study containing 160 foots for 40 persons from images of students and employee in our college, which was more than 4 foot images per person, then discussing specific characteristics of foot biometrics compared to traditional hand and face based techniques. Euclidean distance used in the proposed system because in mathematics- the Euclidean distance or Euclidean metric is the "ordinary" distance between two measured points. MATLAB version 8.1(R2013a) has been used to implement the proposed method.***

Keywords -***Biometric recognition, Foot geometry, Euclidean distance.***

1. Introduction

The reliability of the system based on the use of biometrics information (such as foot)that takes a spread significantly compared with the reliability of the traditional systems to recognize a query person. In fact using the biometric gives high accuracy and ability of easily recognition between the authorized and unauthorized users.

The advantage of using the biometrics depends on the personal attributes to identify the users. In addition, it doesn't need to save multiple passwords that are vulnerable to theft or forgetfulness that gives these systems a great acceptance among users. The extraction of the individual characteristics to deal with people will help users to get quickly and high accuracy results.

The biometrics contain a number of properties; these can be divided into behavioral biometrics which are the behavior characteristics and physical characteristics. The behavior characteristics such as signature, gait, and hand-writing print ….etc., while physical characteristics refer to structural pattern of human such as ear print, palm print, fingerprint …etc. [1].

The human foot is a complex arrangement of bones, ligaments and muscles that allow for the fine control of the human locomotion or posture. This bundle, represented in figure 1, has quite a good number of degrees-of-freedom that are not represented in the biomechanical model used in gait or posture analysis. Furthermore, if the foot is to be represented as a single rigid body then there is no point in defining the muscle actuators that are responsible for its 'deformation' and 'adaptation' to the contact surface. The geometric description of the foot surfaces that will be involved in the contact and their equivalent material properties have an extra importance[2].In this paper, some geometric features (16geometric features from foot) are extracted to any person.

2. Foot Geometry

The foot geometry technology based on the fact that every person has a special shape of foot belongs to him only, which is not affected by factors of time and aging. The foot size is relatively stable if the human has completed the growth phase and not properly use this type of measurements on children or those who are in the growth phase of their life. In other words, adult persons owning a distinctive unique foot among the rest of the people, foot geometry system always bases on the biometric features of the foot and some specifics measurements such as length and width of the foot [3].

3. The Proposed Foot Geometric Recognition System

The system's architecture as shows in Figure.1 relies on three different techniques adopted on fingerprint verification [4], face recognition [5] and hand geometry [6] and consists of the following modules.

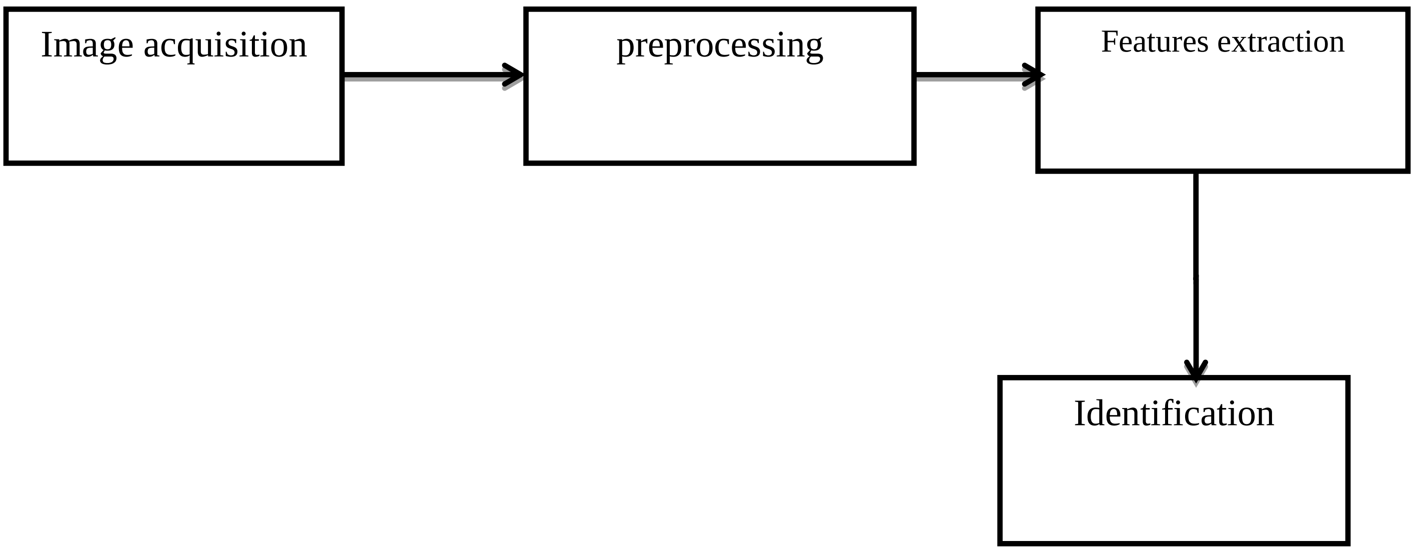

Figure.1: The phases for any features extraction

3.1Image Acquisition

Images took by digital camera, while people should stand by a fixed distance from the camera to almost2 meters with fixed lighting and background. Camera's resolution is 20Mega pixel, and zoom50 degrees.(as shown in figure 2).

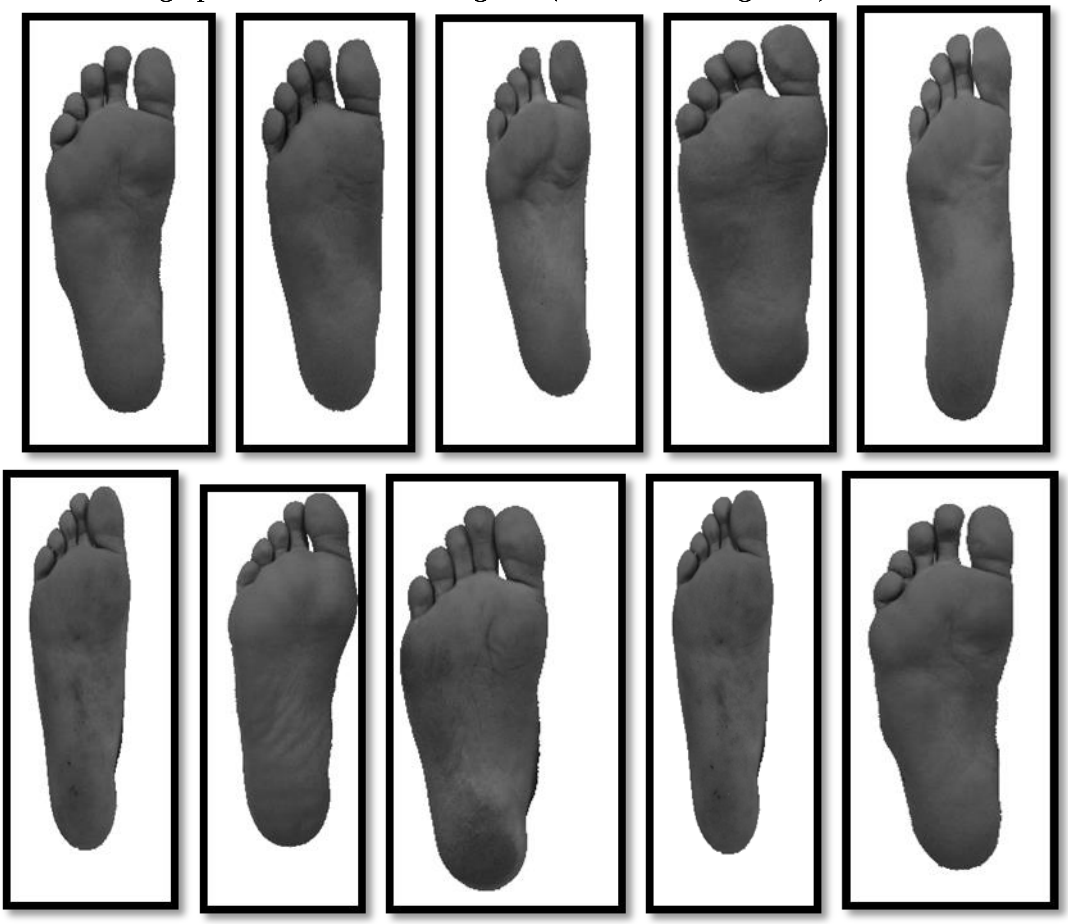

Figure.2:image foot of 10 person

3.2 Image Preprocessing

The next step is image preprocessing module. Image preprocessing relates to the preparation images for the next analysis and usage. Images captured by a camera or any similar techniques may need improvement to reduce noises in image; some images may need to simplified, enhanced segmented, filtered, etc. The role of the preprocessing module is to prepare the image for feature extraction. The first step in the preprocessing is to transform the color image into a gray scale image resulting to noisy gray scale image. Next step is the filtering which used in order to cancel the presented noise. Then, edge detection algorithm is applied for obtaining edge of the noiseless gray scale image. Image preprocessing module consists of the following operations:

(i) Gray scale image
(ii) Noise removal
(iii) Edge detection.

(i) Gray Scale Image

Digital image processing is necessary which colored foot image convert into gray scale image. Basically gray scale is an image in which the value of each pixel is a single sample, that is, it carries only intensity information. Images of this sort, also known as black-and-white, are composed exclusively of shades of gray, varying from black at the weakest intensity to white at the strongest. Now color foot image is converted in to gray scale image with noise because there is some noise present in the input colored image due to dust and atmospheric conditions. This noise removal is essential for the system[7].

(ii) Noise Removal

By knowing the difference between the actual foot and captured image. This causes the variation in database feature and measured feature also affected the accuracy of the system. Another reason of noise removal is that edge detection which is difficult in noisy images, since both the noise and the edges contain high frequency content. Basically the noise produced in the image is due to device that used for capturing image for the foot, atmosphere condition or surrounding. There are many methods to remove the noise. In this proposed system the noise removed by using wiener2 filter, but before extracting features from the image, it is important to remove the noise from the image. Attempts to reduce the noise result in blurred and distorted edges. Operators used on noisy images are typically larger in scope, so they can average enough data to discount localized noisy pixels. This results in less accurate localization of the detected edges[8].

(iii) Edge Detection

In order to extract geometric features of the foot, it is required image contains only edges. Edge detection is the process of localizing pixel intensity transitions. The edge detection has been used by object recognition, target tracking, segmentation, and etc. Let‘s consider the boundary detection under image enhancement because the goal is to emphasize features of interest i.e. boundaries and attenuate everything else.

An edge is a collection of connected high frequency points in an image. Visually, it is a region in an image where is a sharp change in intensity of the image. Edge detection refers to the operation performed on an image to detect the edges in an image. Edge detection plays a vital role in object detection and feature extraction and plays pivotal role in machine vision. There are different types of edges – step edges, roof edges, line edges, color edges, gray level edges, texture edges etc.

Not all edges are detected by all edge detection operators. Each operation has its specific specialty in edges and better the edge detection, usually; more complex and costly is the operation. Therefore, the edge detection is one of the most important parts of image preprocessing. There mainly edge detection method Canny[9].

With binary thresholding on the original image B to keep the most significant edges only, which reliably represent foot contours. Then, within the obtained image B1 we fill the interior of the foot using binary thresholding on B, i.e.

$$B2(X,Y) = \max\big(bin(B)(X,Y), B1(X,Y)\big)\, where\ bin_b(B)$$

denotes the binarization of B using threshold b. This binarized image B2 is next subjected to morphological dilation using a square structuring element S to close the boundary:

$$B3 = B2 \oplus S = \{(X,Y) | S_{XY} \cap B2 \neq \emptyset \qquad (1)$$

where Sxy denotes a shift of S by (x, y). This operation is followed by a removal of small white 4-connected binary large objects (BLOBs) of all black BLOBs except the background to get the binarized image B4.

Last, we employ morphological erosion on this image.

$$B3 = B5 \otimes S = \{(X,Y) | S_{xy} \subseteq B4 \qquad (2)$$

(as shown in figure 3)

a)gray image b) The Edge Detected Image

Figure.3: The gray image and The Edge Detected Input Image

4. Geometric Features

Geometric measurements are frequently employed in hand biometric systems due to their robustness to environmental conditions, and a large number of possible features fall into this category. Considering the sole of the foot to be prone to injuries, shape-based features well suited for the foot verification task. However, due to different spreadings of toes, we expect a rather high intra-personal variability in general. One reason for this is that many hand recognition schemes rely on a robust identification of finger tips and finger valleys. When inter finger valleys cannot be detected reliably, a normalization, i.e., correct placement of individual fingers, is hard to achieve. The extraction of these characteristic landmarks is often facilitated by pegs [10], while more advanced schemes like [11] are peg-free but demand high contrast between background and palm. Since an introduction of pegs is unacceptable for the image acquisition step, and spread toes are not the default case, the reliable detection of inter toe valleys deserves closer attention in foot biometrics. Regardless the expected weak performance of shape features, we try to map both global features (focusing on palm width, length or hand area).

5. Features extraction

At the end of preprocessing phase, getting an image of gray level which describes all edges in the original one ,where the longest and most prominent edge in that image is the edge that represents the boundary of foot shape ,then used chain code algorithm for representation, which describes the point location edges of the image, this algorithm is one of the most efficient algorithm to describe the boundary of objects within the image, because their ability to never effect from rotation as it gave good results when used ,the most used features are following :

5.1.Foot Width

Observes that people differences with foot shape during data preparation, some people have a width foot and another have a normal or less width foot compared with the first one, also observe that some people have the foot area near the fingers having width more than the bottom of the foot area. foot width is defined as the distance between the left and right side point ,we can find three width from foot:

- from the center point by founding the first width in the center of the foot.
- second width is found near and above the center of the fingers.
- third width is found below the center of the foot .

(as shown in figure 4)

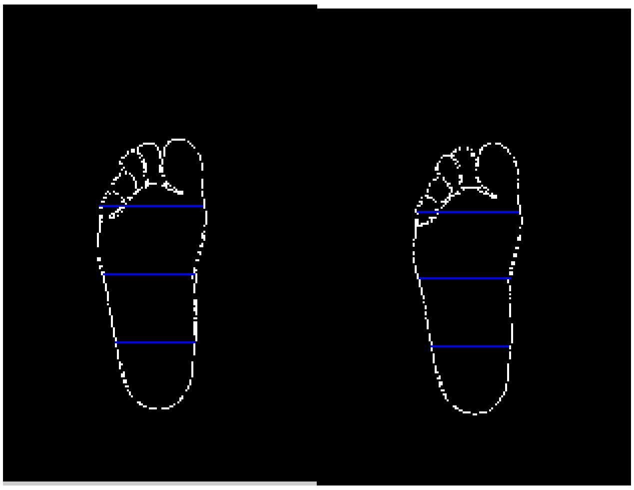

Figure.4: The three width

5.2 Foot length

As known that the people have a unique difference in width and length of their foot, and using this point as a one of the features in this proposed work. Foot length is defined as the distance between the top fingertip point and the bottom foot point.(as shown in figure 5)

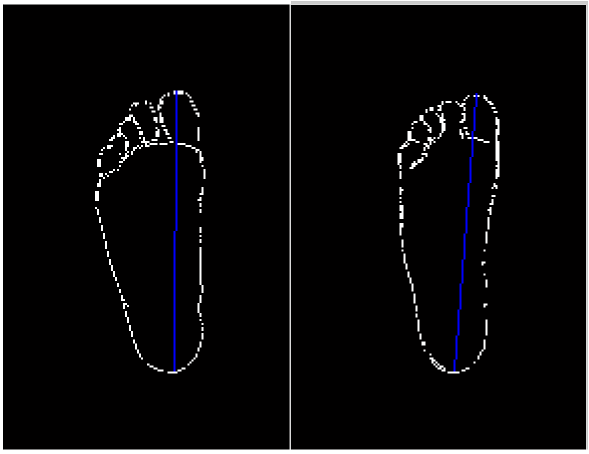

Figure.5: The length

5.3 Center point

The center point is one of the best special characteristic for people recognition, it's calculating depend on the centroid of gravity as in the following equation.

$$Xc = \frac{\sum_{i=1}^{n} X_{ci}\ L_i}{L}, y_c \frac{\sum_{i=1}^{n} y_{ci}\ Li}{l}, \quad where\ l = \sum_{i=1}^{n} L \quad (3)$$

The line segment Li, has the centroid Ci with coordinates
xCi , yCi , i = 1; …….n.

After that measuringthe distances starting from the corner 0 to the corner 330(as shown in figure 6)

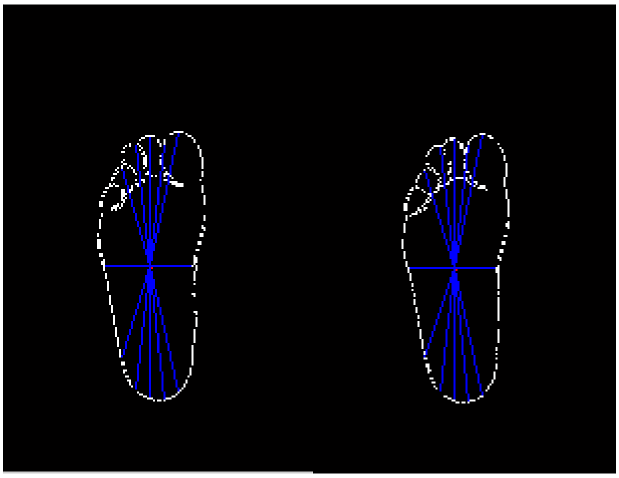

Figure.6: The length the measurements distances starting from the corner 0 tothe corner 330

A list of implemented features for the footprint-based identification task can be found in Table I.

Table (1) summarize the extracted features and the number of each one

	The extracted geometric features	Number of lines
1	Foot width	3
2	Foot length	1
3	Foot center point	12

6. Conclusions

From the experiment results, Were extracted 3 geometric features to each from foot .the proposed method has been applied on the foot image was taken by digital camera and scanner for getting optimal results, one can use all the 16 geometric features , .determine the foot center, and then we calculated the distance between the center and outer point by different angles were measured .the angles are from 0^o to 330^o by increment with 30^o gradual.

And we can find three width from foot: from the center point by founding the first width in the center of the foot, second width is found near and above the center of the fingers, and find third width below the center of the foot. Finally Foot length is defined as the distance between the top fingertip point and the bottom foot point.

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