Multiple Feature Extraction for Foot Print Image

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Abstract: In this paper we introduce the new biometric of FOOT PRINT RECOGNITION SYSTEM. This foot image is proved to be distinct for every human being. On the image of the footprint obtained we perform pre-processing. Next we perform the vital step of feature extraction. The best part of this technique is that we use multiple feature extraction techniques. This feature from the foot image is extracted, classified and then recognized. The use of multiple feature extraction will provide us with better accuracy.

Keywords: Footprint, Gabor Filter, Wavelet, FNN, SVM

1. INTRODUCTION

Numerous inimitable methods are being developed in the field of automated biometric based identification. Various biometric features help in person recognition. Among various methods of person identification, biometric identification such as finger scan or iris scan is the most promising methods now. Similarly, person identification using footprint is also an emergency biometric technique. Also footprint recognition is considered to be a unique method[1][2] as it as been evidently proved. Thus, in the aspect of human friendliness footprint based recognition can be a promising method. The main problem in automatic Kazuki Nakajima et.al.,[3](2000) proposed the foot print based recognition in which a new method of personal recognition based on footprints. In this method, an input pair of raw footprints is normalized, both in direction and in position for robustness image-matching between the input pair of footprints and the pair of registered footprints. In addition to the Euclidean distance between them, the geometric information of the input footprint is used prior to the normalization, i.e., directional and positional information. In the experiment, the pressure distribution of the footprint was measured with a pressure-sensing mat.

A high recognition rate is difficult to obtain, because people stand in various positions with different distances and angles between the two feet. To achieve robustness in matching an input pair of footprints with those of registered footprints, the input pair of footprints must be normalized in position and direction. Such normalization or sync might remove useful information for recognition, so geometric information of the footprint prior to normalization into an evaluation function for personal recognition decision is included.

He uses a BIG-MAT sensor to acquire the pressure distribudion of footprints. Ten footprints were taken into the database where different footwear are taken into foot acquisition. Finally the center of mass is moved to the center of frame. A new personal recognition method based on footprints. Plantar foot pressure and its distribution have previously been studied to evaluate neuropathic foot ulceration and arch height, and in the biomechanical field . Foot structure has been characterized using radiographs . Peaks of high pressure under the feet are frequently accorded clinical attention because of their potential to cause mechanical damage to the plantar tissue. Lord recorded pedbarograms from a neuropathic diabetic patient standing barefoot.

Sean W. Yip, B.S. et.al.,[4](2004) analyzed the force distribution measurement beneath the feet. The postural control system's performance may be helpful in identifying persons with an increased possibility of falling. Postural performance is often characterized using center of pressure, but force distribution under the feet may provide additional information on the state of the postural control system. Foot position and orientation can also be extracted from force distribution without the need for manually tracing footprints. The force distribution measurement system is being developed to complement an existing dual force-plate platform is of very low cost. The sensing module of the system contains 1024 1-cm by 1-cm FSRs. Interface electronics were designed to convert the FSR outputs to binary data. Continuously sampling the FSR outputs allows one to monitor force distribution over time. Force distribution measurements not only allow force changes under localized regions to be examined, but can also be used to extract foot position and orientation. In standing balance tests, foot position and orientation have been found to affect postural sway and the mean position of the COP. Thus, foot position and orientation can be valuable when characterizing postural Performance using COP. Foot position and orientation may be obtained from a manual tracing of the subject's footprints. The process generally takes about 1-2 minutes. This is not a problem for normal individuals. However, subjects with problems maintaining a stable stance, such as Parkinson patients, may not be able to keep their feet in position long enough for the tracing to be completed. Force distribution measurements will be able to provide the subject's foot position and orientation in a fraction of the time needed for manual tracing.

The calibration apparatus is made of two aluminum plates separated by about 4 cm. An air bladder wrapped in double layers of polyester is inserted into the space between the plates. Two air hoses are attached to one side of the air bladder. One hose is connected to an air compressor while the other one is connected to an air valve assembly and an electronic pressure gauge.

Once the operation of the system is validated, it will be mounted on a dual force-plate platform so that COP and force distribution can be measured simultaneously. The measurements will be used to characterize the differences in the performance of the postural control system between normal subjects and subjects with known falling risk.

Pier Luigi Dragotti et.al.,[5] analyzed footprint and edge prints for image denoising and compression.

He states that wavelets have been quite successful in compression or denoising applications. To further improve the performance of wavelet based algorithms, he has recently introduced the notion of footprint, which is a data structure which contains all the wavelet coefficients generated by a discontinuity. The combined use of wavelets and footprints leads to very efficient algorithms for compression and denoising of l-D piecewise smooth signals. He extend some of the previous results. He present a new denoising algorithm, where footprints are chosen adaptively according to the singularity locations. This new algorithm outperforms previously proposed ones.

The design of a complete or over complete expansion that allows for compact representation of arbitrary signals is a central problem in signal processing applications. Wavelets, for instance, are known to be good approximants for 1-D piecewise smooth signals. The choice of a good basis, however, is only one of the elements that makes an efficient compression algorithm. Footprints are a powerful tool for signal compression and denoising, but they work only on one-dimensional signals. Thus, it is natural to look for an extension to the two dimensional case. He have proposed a new denoising algorithm based on footprints. The main innovation of this algorithm is that footprints are chosen according to the estimated distance between singularities. Moreover, he has investigated a possible generalization of footprints to the 2-D case.

Jin -Woo Jung et.al.,[6] proposed that Dynamic-Footprint based Person Identification using Mat-type Pressure Sensor

In the field of biometric identification as human-friendliness has been emphasized in the intelligent system's area. And one of emerging method is to use human walking behavior. But, in the previous methods based on human gait, stable somewhat long-term walking data are an essential condition for person recognition. Therefore, these methods are difficult to cope with various change of walking velocity which may be generated frequently during real walking.

A new method which uses just one-step walking data from mat-type pressure sensor is used here. When a human walk through the pressure sensor, he gets quantized COP (Center of Pressure) trajectory and HMM (Hidden Markov Model) is used to make probability models for user's each foot. And then, HMMs for two feet are combined for better performance by Levenberg-Marquart learning method.

A new method which uses direction-based quantization of COP trajectory, hidden markov model and Levenberg-Marquart learning method to apply in various change of walking velocity in real environment is adopted in this technique. Since some people have strong characteristic on left foot and other people have it on right foot, we can predict that recognizing with one-step data will show better performance than recognizing with one-foot data. Since the comparison of output probabilities of two HMM can be possible only when the lengths of input sequences are equal, we need an additional assumption that walking speed of left foot and right foot are almost equal.

A person recognition method based on mat-type pressure sensor which can be applied in various change of walking velocity by the help of modified HMM which can identify person regardless of sequence length. Directionally-aligned and quantized COP trajectory was used to be a feature for representing dynamic footprint. And, by the observation that recognizing with one-step, i.e. two-feet, will show better performance than recognizing with one-foot, he has made HMM-based recognizer for one step footprint. And, combined by Levenberg-Marquart learning method, this modified recognizer showed 64% average recognition rate for 8 men's natural walking experiment

Proposed Method:

The working on the image is a 3 step process. It starts with the pre-processing of the image then feature extraction and then the final stage is to perform classification based recognition. The working of the FOOT PRINT RECOGNITION SYSTEM is depicted in the figure 1.

The foot print recognition is carried out in 2 ways.

1. PCA with SVM

2. Wavelet based Fuzzy neural Network

In the first method we carry out feature extraction using Gabor Filter. In the second technique the feature extraction is carried out by the use of wavelets. These two techniques are discussed in this section.

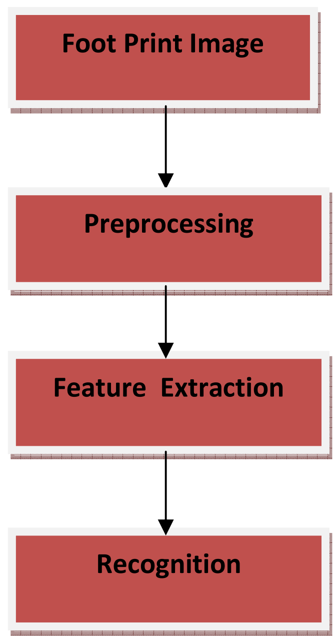

Fig 1. FPRS System Structure

Gabor Filter based feature extraction: Gabor Filters are used to smooth out noise and preserving the true ridge valley structures in addition to orientation of footprint image.

The general form of a 2D Gabor filter is shown below:

$$h(x, y, \theta, f, \sigma x, \sigma y) = \exp\left[-\frac{1}{2}\left(\frac{x'^2}{\sigma_x^2} + \frac{y'^2}{\sigma_y^2}\right)\right] \times \exp(i2\Pi f x')$$

$$x^{'} = x\cos\theta + y\sin\theta$$

$$y^{'} = x\sin\theta + y\cos\theta$$

f: the frequency of the sinusoidal plane wave,

θ: the orientation of the Gabor filter,

σx and σy : the standard deviations of the Gaussian envelope along the x and y axes respectively.

In our research we apply a band of six Gabor filters $\left(0^{\theta}, 30^{\theta}, 60^{\theta}, 90^{\theta}, 120^{\theta}, 150^{\theta}\right)$ and a frequency, f= 10 which corresponds to the reciprocal of the average inter-ridge distance. Finally, 25 x 25 x 6 = 3750 Gabor features are extracted from each image. Comparison of features with normalization or without normalization may affect the results of the system performance, both of the features are used in the verification stage. To normalize the features, all of the features are scaled to the range of [0, 1] by

$$n = (O - \min)/(Max - \min)$$

where ,

n : the normalized feature

O : the original feature

Min: the maximum value of all features.

Max : the minimum value of all features.

Wavelet based Feature extraction

In feature extraction we use the concept of wavelet transform for the processing of the image. Primarily the image is taken and Discrete Wavelet Transform (DWT) is applied. By applying this we do the base selection this is regarded as the mother wavelet derived from the image. Then we obtain the wavelet coefficients from the mother wavelet. These wavelet coefficients are found using the level of decomposition. We in this system use 4 level decomposition as shown in the Fig 3.

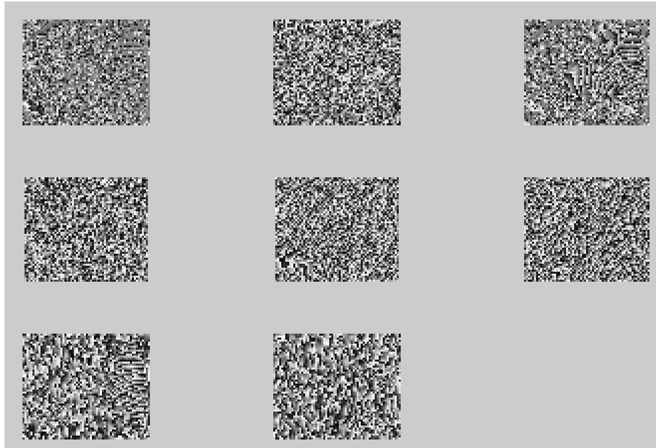

Fig 2.Feature Extraction

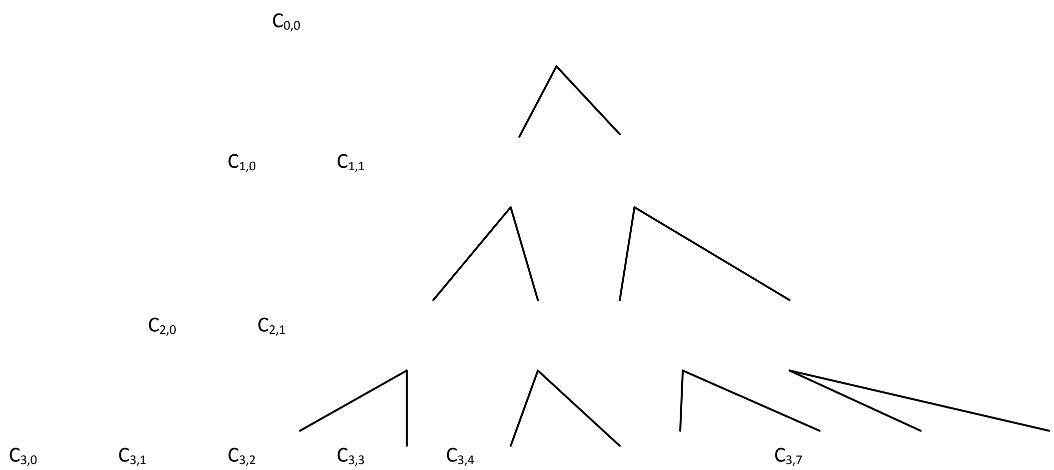

Fig.3 Levels of decomposition denoting Co-efficient

The summation of the squares of these coefficients will result in the component called Energy which can be compared. This can be depicted in the equation (3) for the contribution of the energy for desired image. This Energy value obtained is used as an input for the next process.

$$Energy = \sum_{i,j=1}^{N} C_{i,j}^{2} \qquad \text{Eq.1}$$

2. RESULT AND DISCUSSION

The discussion in this chapter is a biometric recognition using footprints of a person. Earlier work deals with capturing footprint on a paper or on a surface. This won't give us accurate foot print, since it depends on nature of the surface, quality of the paper and proper placement of the foot to give good foot print impression. To avoid all these we proposed a touch less method to obtain foot prints. The footprint can be obtained using any digital camera. We can take footprint image in many angles to conform the individuality of a person. In this work we used Principle Component Analysis (PCA) for pattern recognition and feature extraction. We have given two snap shots for the feature extraction in the fig no 8 and 9. Then the SVM classifier split the patterns in to relevant classes. In early stage of our work itself we got remarkable quality and it is comparatively better than conventional footprint images obtained using paper or surface.

A GUI is developed using R2010 MATLAB tools from which the following steps leads to the ultimate result.

INPUT	OUTPUT
Raw Image	Loaded in database
Loaded image	Preprocessed image
Preprocessed image	Filtered image
Filtered image	Contrast enhanced image
Contrast enhanced image	Feature Extraction

A class has group of images if a single data. Each class consists of an individual matrix. Concatenation of the matrix generates matrix which comprises of all the data, it is processed and classified with the range values of each test data set. Accordingly the images trained are matched with the metrics so that it gets classified to the nearest predicted vector. In this case the predicted class is identified and recognized based on the nearest proximity of the value which comes under the range of the trained class image given in the database. In this the trained values are set in terms of numeric and it can also be transferred in character format for analyzing the image without the value of the predicted class.

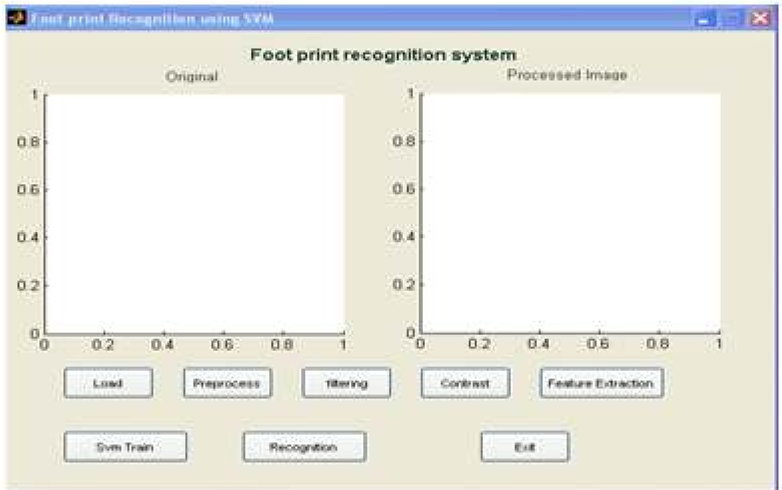

Fig.4 Graphical User Interface

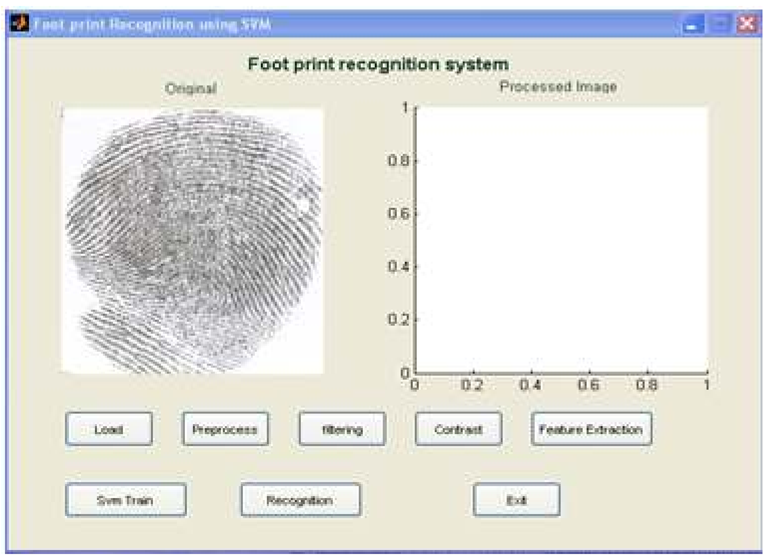

Fig.5 Test Image

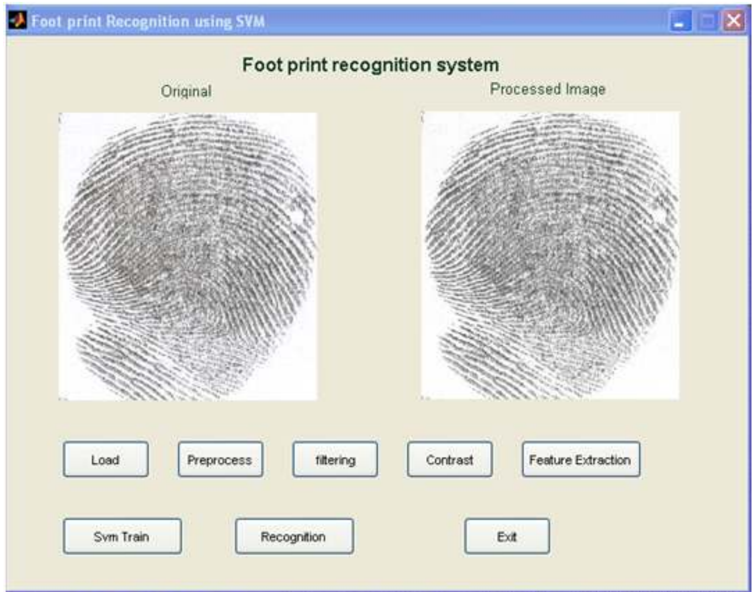

Fig.6 Pre-processing

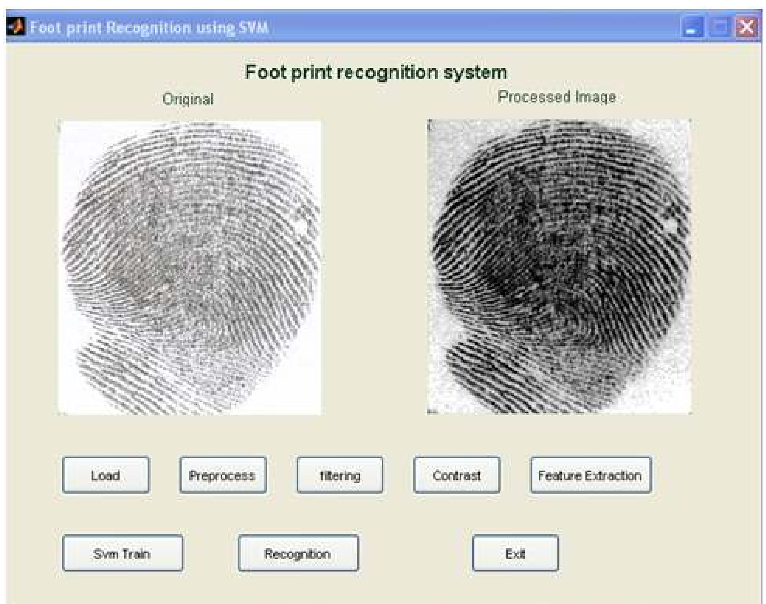

Fig.7 Contrast Enhancement

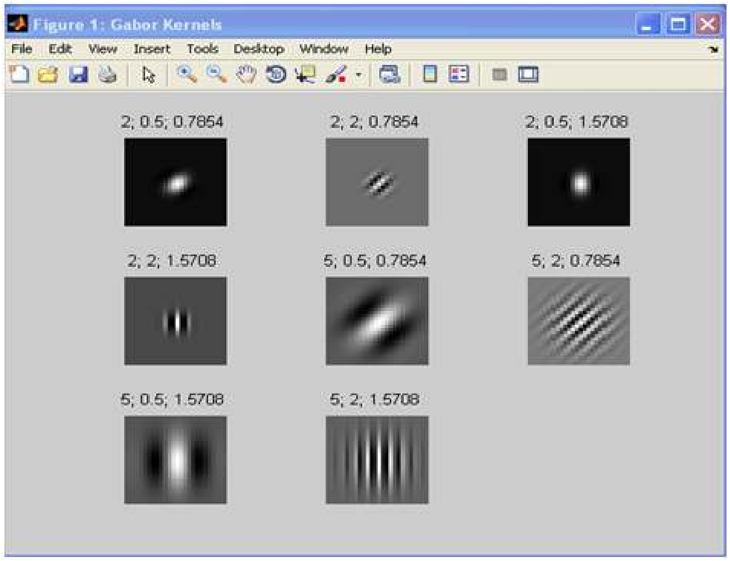

Fig.8 Feature Extraction-I

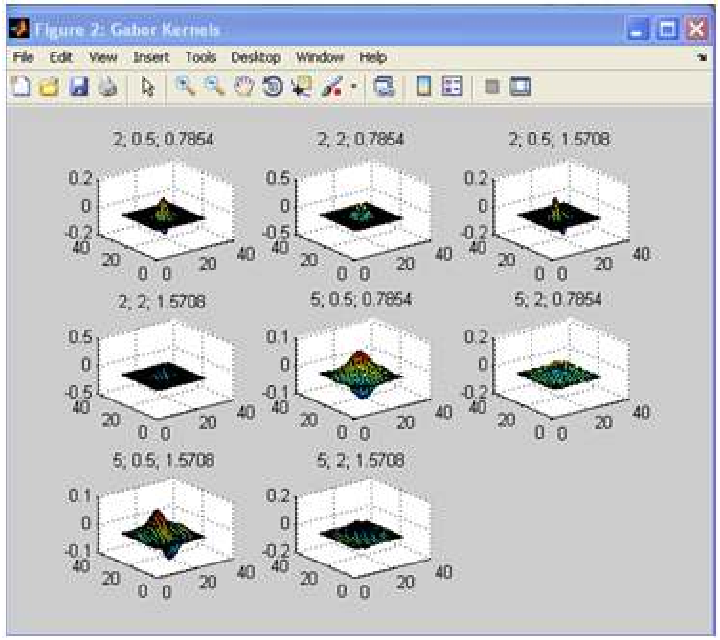

Fig.9 Feature Extraction-II

3. CONCLUSION

A detailed study of the foot print image is carried out and the accuracy of the image is found to be very good. The use of 2 feature extraction methods has provided us with an accurate result which can be proved both theoretically as well as practically. In future we use the techniques of PCA-SVM and FUZZY NEURAL NETWORK to enhance the recognition technique.

4. REFERENCES

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