MANIFOLD FEATURE EXTRACTION FOR FOOT PRINT IMAGE

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Abstract

In this paper, the new biometric of FOOT PRINT RECOGNITION SYSTEM have been introduced. The foot image is proved to be distinct for every human being. On the image of the footprint obtained we performed pre-processing followed by the vital step of feature extraction. The best part of this technique is the use of 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 and footprint recognition is considered to be a unique method [1] [2] as it has been evidently proved. Thus in the aspect of human friendliness, footprint based recognition can be a promising method.

Nakajima et.al.,[3](2000) proposed 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. Furthermore, a high recognition rate is difficult to obtain, because of the possibilities of various positions with different distances and angles between the two feet in standing position. Hence the input pair of footprints must be normalized in position and direction in order to achieve robustness in matching an input pair of footprints with those of registered footprints. 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.

The personal recognition methods based on footprints which was proposed by Nakajima et.al, [3] (2000) involves the utilisation of a BIG-MAT sensor to acquire the pressure distribution of footprints. Ten footprints were taken into the database where different foot wears were taken into foot acquisition. Finally the centre of mass is moved to the centre of frame. 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.

Sean et.al.,[4](2004) analyzed the force distribution measurement beneath the feet. According to their study, the postural control system's performance helps in identifying persons with an increased possibility of falling. The study further adds to the point that, postural performance is often characterized using centre of pressure, but force distribution under the feet may provide additional information on the state of the postural control system. It is also possible to extract foot position and orientation 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 which is less expensive when compared with the other. It was confirmed that, the sensing module of the system contains 1024 1-cm by 1-cm Force Sensitive Resistors (FSR). 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 (Center of Pressure). 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. In such cases, 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.

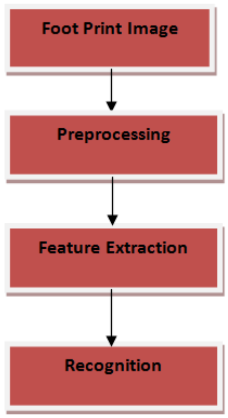
Pier Luigi Dragotti et.al, [5] analyzed footprint and edge prints for image denoising and compression. He states that wavelets have been quite successful in compression or denoising applications. To further improve the performance of wavelet based algorithms, he has recently introduced the notion of footprint, which is a data structure containing all the wavelet coefficients generated by discontinuity. The combined use of wavelets and footprints leads to very efficient algorithms for compression and denoising of l-D piecewise smooth signals. He extended some of the previous results by 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 make 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 has 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 the 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. Hence, a new method of just one-step walking data from mat-type pressure sensor was developed. 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 to identify person, regardless of sequence length 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. Directionally-aligned and quantized COP trajectory was used as a feature for representing dynamic footprint. HMM-based recognizer recognizes one-step, i.e. two-feet and observations were made which, will show better performance than recognizing with one-foot. Combined by Levenberg-Marquart learning method, this modified recognizer showed 64% average recognition rate for 8 men's natural walking experiment

2. 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.

Fig.1. *FPRS System Structure*



The foot print recognition is carried out in 2 ways.

1. PCA with SVM
2. Wavelet based Fuzzy neural Network

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

2.1 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,

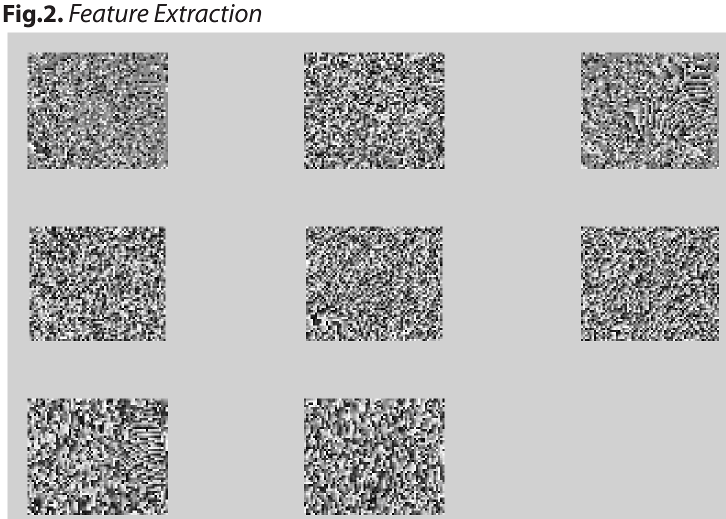
σx and σy : the standard deviations of the Gaussian envelope along the x and y axes respectively.

In the present study a band of six Gabor filtersand $(0^{\theta},30^{\theta},60^{\theta},90^{\theta},120^{\theta},150^{\theta})$ a frequency, f= 10 which corresponds to the reciprocal of the average inter-ridge distance are applied. 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.

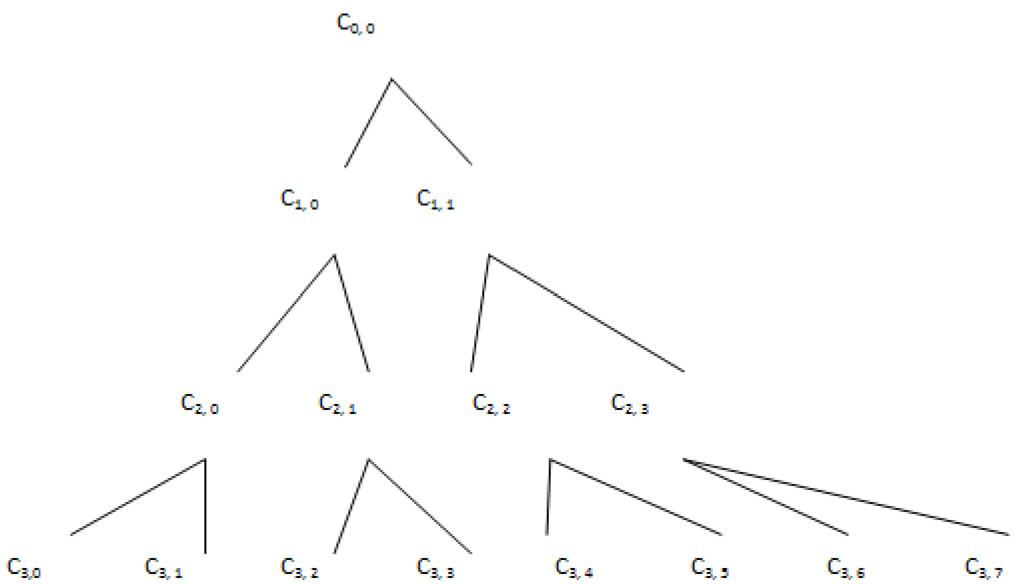
Fig.2. *Feature Extraction*



2.2 Wavelet based Feature extraction

In feature extraction, the concept of wavelet transform is used for the processing of the image. Primarily the image is taken and Discrete Wavelet Transform (DWT) is applied. By applying this base selection, the mother wavelet can be derived from the image. Then the wavelet coefficients from the mother wavelet was obtained which was found using the level of decomposition. A 4 level decomposition was used in this system as shown in the Fig 3.

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.

$$Energy = \sum_{i,j=1}^{N} C_{i,j}^{2} \qquad (1)$$

3. Conclusion

A detailed study of the foot print image was carried out and the accuracy of the image was 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 studies, the techniques of PCA-SVM and FUZZY NEURAL NETWORK can be carried out to enhance the recognition technique.

4. References

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