Investigation of Probabilistic Graphical Model Algorithms for Palm print Verification

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ABSTRACT
Palmprint is emerging as a popular biometric based personal identification technique and has been found to be more advantageous than fingerprint because of its larger area to capture more distinctive features. Most of the fingerprint discriminative features are also found in Palmprints. Palmprint feature extraction is one of the most important stages in the verification process. The robustness of the system depends on the feature extraction methodology and its ability to extract features from the palmprint. In this paper we propose a global feature extraction based on the Discrete Cosine Transform and investigate the efficiency of BayesNet algorithm for verification. This work also investigated the effect of feature reduction using information gain on the proposed methodology. This work utilized 50 palmprints of different users from the palmprint database provided by the Hong Kong Polytechnic University (HK-PolyU) to evaluate the proposed methodology.

Keywords
Biometrics, Palmprint, Discrete cosine transform, Segmentation, Naïve Bayes, Decision Tree Induction.

1. INTRODUCTION
Access control plays a very important role to provide identity, authentication and authority for a person to access resources. The resources can be a physical facility like entering a airport or it can be to access resources in a computer system[1]. Traditional methods of access control including passwords, access control cards have failed at one stage or other as it can be duplicated, lost or stolen. Biometrics is the field of automation involved in identifying a person based on either his physiological characteristic or behavioral characteristic. Physiological characteristics[2] are unique features obtained from the human body and includes fingerprints, face, palmprint, iris, retina vein and hand geometry. Behavioral characteristics based biometrics include typing rhythm, gait and voice.

Fingerprint is one of the most popular Biometric modality[3] as it has the advantage of using multiple finger, low storage space and has been proven effective in many large scale implementations. However fingerprint based biometric has the disadvantage of poor fingerprint image in the case of individual's age and occupation. Iris based biometrics[4] has the advantage of being a non contact based image capture and less prone to injury. Iris based systems suffer from difficulty in image capturing from some individuals and the difficulty of manual verification by a human. Face biometrics[5] are very easy to implement as ordinary web camera can be used for capturing the face image but faces the disadvantage of the system being sensitive to changes in lighting, expression and pose. Similarly hand geometry[6] is easy to capture but its performance degrades as the number of users increases. Among the behavioral characteristics voice[7] has been proved to be easily utilized but suffers from distinctness for identification in large databases. Palmprint biometrics[8] has many of the characteristics of fingerprint recognition. Both are based on the friction ridge impression which includes ridge flow and ridge structure in the epidermis. Palmprint biometric is increasingly becoming popular due to its ruggedness compared to other biometric techniques and its ease of use.

In this paper we investigate feature extraction using the Discrete Cosine Transform(DCT) and feature reduction using Information Gain(IG). Verification is achieved using BayesNet where the probabilistic relationship among the attributes is represented by Directed Acrylic Graph(DAG). This paper is organized into the following sections. Section 2 studies some of the existing work in palmprint biometrics, section 3 discusses the proposed methodology followed by section 4 which concludes the paper.

2. LITERATURE REVIEW
Zhang et al., [9] proposed an online palmprint identification system based on novel hardware using ring source, CCD camera, frame grabber and an analog to digital converter. 2D gabor phase coding scheme was used for feature extraction with normalized Hamming to measure the similarity. Accuracy in identifying genuine palmprints was 98% with a low false acceptance rate of 0.04 percent. The total execution time (feature extraction and matching) was in the range of 0.6 seconds in a database containing 100 persons with three palmprint each.

Dai et al., [10]proposed a multifeature based palmprint recognition system for high resolution images. Features used in their work included minutiae extraction, principal lines, density and orientation of features. The proposed quality based adaptive orientation field estimation has very good performance for palmprint with large number of creases. The extracted features were fused using SVMs and Neyman-Pearson rule. Using 14,576 palmprints the proposed methodology achieved 16% False rejection rate at a false acceptance rate of 0.00001.

A novel method using features extracted from wavelet based pseudo Zernike moments was proposed by Pang et al.,.[11]. The methodology proposed is more robust against image noise. The proposed algorithm has geometrical invariants property with nearly zero redundancy measure due to its orthogonality property. The advantage of using wavelet is its localization property. The proposed method was able to achieve 4.28% FAR when the FRR is at 4.32%. The overall verification rate of the proposed method is 95.72%.

Jing et al.,[12] proposed a multimodal biometric using face and palmprint characteristic. The work concentrated on a small dataset with image fusion at the image pixel level. Features were extracted from the face and palmprint images using Gabor transform. A novel algorithm Kernel discriminative common vectors(KDCV) was proposed and tested. The mean recognition rate obtained was 92.66% when two samples were used for training and mean recognition rate of 96.14% when three of the samples were used for training.

Chih-Lung Lin et al.,proposed a two finger-webs automatic selection to identify the datum points and subsequently the region interest for the palmprint images. Principal palmprint features were extracted using directional and multi resolution decompositions. To test the proposed methodology 4800 palmprint images were collected from 160 individuals[13]. The proposed method was able to achieve 0.69% FAR when the FRR is at 0.75%.

3. PROPSED METHADOLOGY

In this paper we propose to segment palmprint images of 50 users obtained from Hong Kong Polytechnic University Palmprint Database[14] using a square mask. Feature vectors are extracted from every alternate pixel using Discrete Cosine Transform(DCT). BayesNet algorithm is used for verification and compared with results obtained after reducing the feature size using Information Gain(IG). Figure I shows some of the ROI based palmprint images.

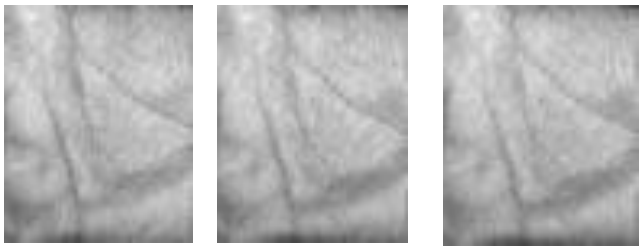

Fig 1: ROI extraction using square mask

A discrete cosine transform (DCT)[15] expresses the data in spatial domain in terms of a sum of cosine functions oscillating at different frequencies. As cosines can express boundary conditions better than other methods it is ideally suited for image processing applications including image compression. DCT can be seen as Fourier related transform but using only real numbers. The variant of DCT used in this work is given by

$$F(u,v)=\left(\frac{2}{N}\right)^{\frac{1}{2}}\left(\frac{2}{M}\right)^{\frac{1}{2}}\sum_{i=0}^{N-1}\sum_{j=0}^{M-1}\Lambda\ i\ .\Lambda\ j\ .\cos\left[\frac{\pi.u}{2.N}\ 2i+1\right]\cos\left[\frac{\pi.v}{2.M}\ 2j+1\right].f\ i,j \quad (1)$$

Where NxM is the image dimension and f(i,j) points to the location of the pixel value.

BayesNet are classifiers which identify the class using the graphical representation of probabilistic relationship for a given set of discrete random variables. Given a set of random variables which are discrete and represented by $X=(X_1,X_2,...)$, a Bayesian network[16] is a Directed Acrylic Graph(DAG) G and is represented by

$$p(X_1,X_2,...X_n)=\prod_i(p(X_i\,|\,P_a(X_i))) \quad (2)$$

Let 'A' be the set of all attributes and Tx the set of all training examples, value(x,a) with $x\in Tx$ defines the value of a specific example x for attribute $x\in A$, H specifies the entropy and $|\ x\ |$ is the number of elements in the set x. The information gain for an attribute $a\in A$ is defined as follows:

$$IG\ Tx,a\ =H\ Tx\ -\sum_{v\in values\ a}\frac{\left|\ x\in Tx\,|value\ x,a\ =v\ \right|}{|Tx|}.H\ \ x\in Tx\,|value\ x,a\ =v \quad (3)$$

Experiments were conducted using 75%,80%,85%, 90% and 95% of the dataset as training data with and without feature set reduction. The verification results by using BayesNet is shown in figure II. Figure III displays the verification accuracy when only 100 attributes are selected after applying information gain.

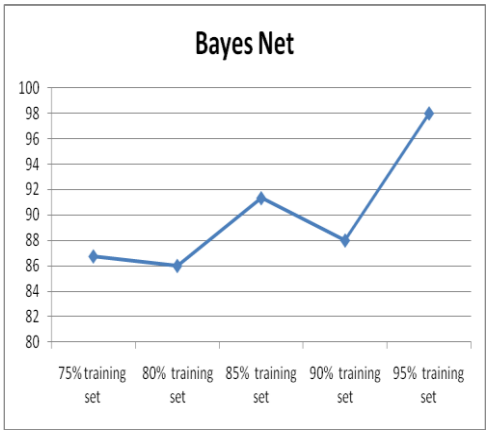

Fig 2: Verification accuracy under various percentage of training data using Bayes Net

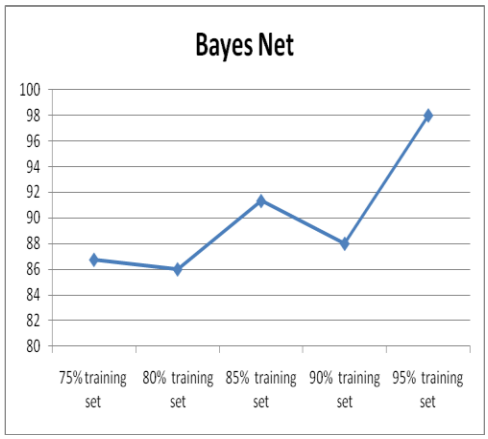

Fig 3: Verification accuracy under various percentage of training data using Information Gain for data reduction

It is seen that the proposed methodology is able to achieve 98% verification accuracy even under sparse feature set. Figure 4 and Figure 5 gives the ROC for Bayesnet and IG-Bayesnet.

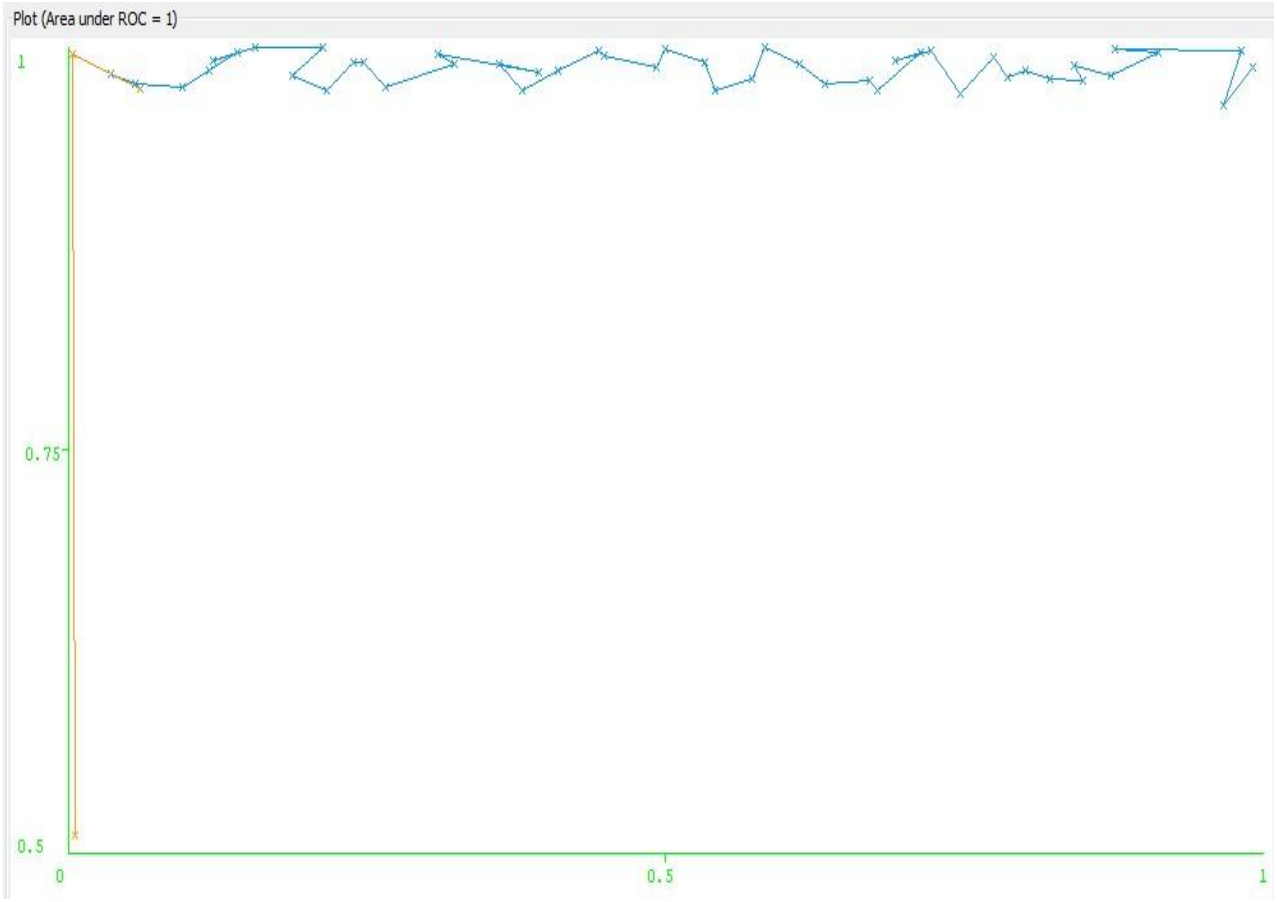

Fig 4: The ROC curve plotting Genuine Acceptant rate vs. False acceptance rate under Bayesnet

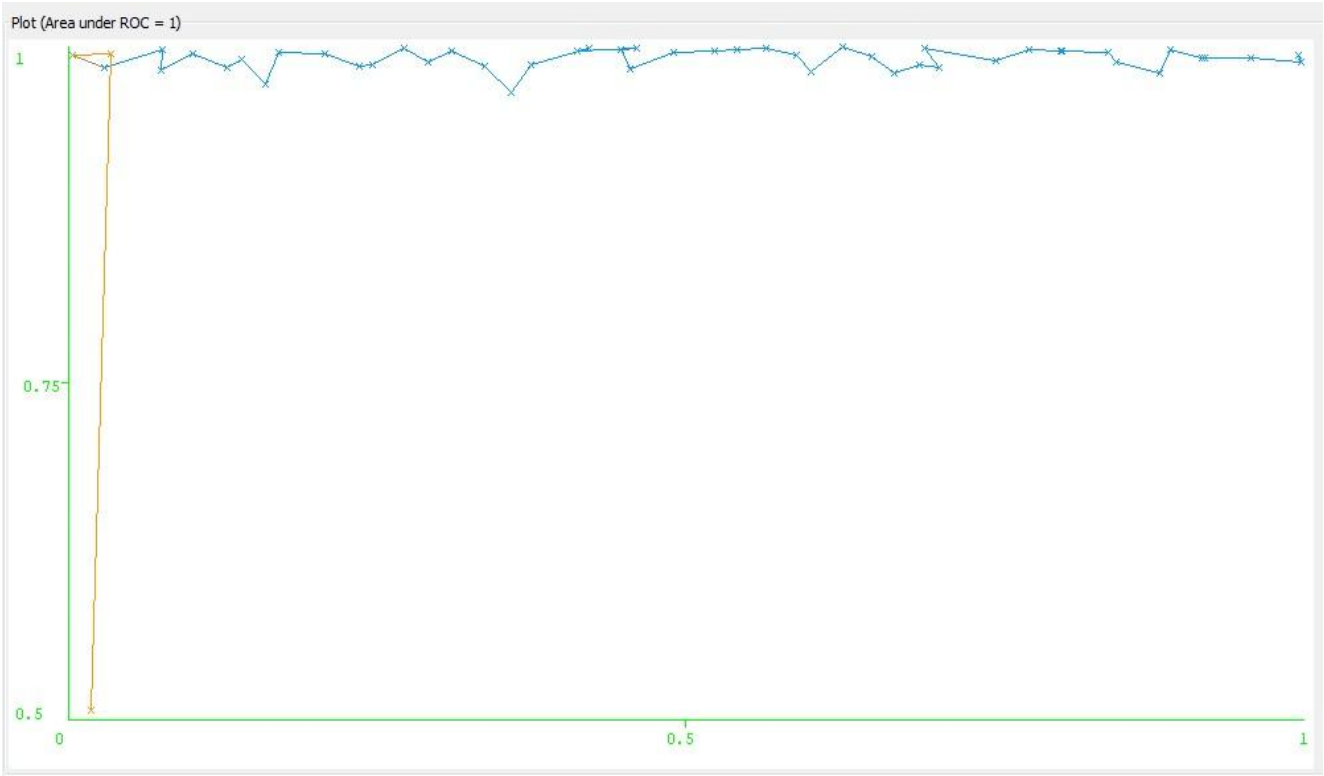

Fig 5: The ROC curve plotting Genuine Acceptant rate vs. False acceptance rate under IG Bayesnet

4. CONCLUSION

In this paper we investigated the efficiency of DCT for palmprint feature vector extraction. Information gain was used to select the best attributes for the verification problem. Bayesnet with various percentage of training data was used to evaluate the accuracy of verification. At larger training data Bayesnet performed extremely well even with very few vectors. Reducing the feature vectors increases the speed of verification by almost 50% in a computer with i3 core processor and 3 Gb RAM.

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