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Feature Vector Extraction based Texture Feature using Hybrid Wavelet Type I & II for Finger Knuckle Prints

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ABSTRACT
The finger knuckle print (FKP) of a particular person is found to be unique and can serve as a biometric feature has been revealed recently by the researchers. In this paper finger knuckle print will be used as a biometric feature. The databaseImages from Hong KongPolytechnic Universitywere processed using Kekre's hybrid wavelet type 1 and type 2 for the generation of results. Kekre's hybrid wavelet type 1 and type 2 were used for feature extraction from the images in order to process it further.The important role of hybrid wavelet transform is to combine the key features of two different orthogonal transforms so that the strengths of both the transform wavelets are used. The hybrid wavelet transforms can be generated using orthogonal transforms such as Discrete Cosine transform (DCT), Walsh transform, Discrete Kekre transform etc. In this paper the different transforms like (Discrete Cosine Transform) DCT, Haar. Hartley, Walsh and Kekre are used in any combination for generation of hybrid wavelets. These hybrid wavelets are applied on the database images to generate feature vector coefficients plotted in graph format and their distances are compared. The intra class and inter class distances are compared in this paper.

Keywords
Finger knuckle print (FKP), hybrid wavelet, region of interest (ROI), Transform.

1. INTRODUCTION
Biometrics deals with identifying humans by their characteristics or traits. Computer science makes use of biometrics for performing identification and access control operations. Individuals under surveillance and in groups can also be identified using their biometric features [1,3].Biometric identifiers aredistinct, measurable characteristics used to tag and describe individuals. Biometric identifiers of an individual are often categorized as their physiological and behavioral characteristics [1,2].

This paper has used Finger knuckle print (FKP) a newly emerged biometric trait. The texture in the outer finger surface, also known as the dorsum of hand, is found to have the potential to do personal authentication. The texture design obtained by bending the finger knuckle of a person is distinct and thus can be used as a biometric trait. The skin pattern on

the finger-knuckle is highly rich in texture due to skin folds and creases, and hence, can be considered as a biometric identifier. Texture rich features make Finger Knuckle Print (FKP) more advantageous and in addition to this it is easily accessible, contact-less image acquisition can be done, it is invariant to feelings and other behavioral aspects such as fatigue, stable features and tolerability in the society[4,5,23].Typical Knuckle-Print image is shown in Figure 1, taken from the PolyU Hong Kong FKP database.

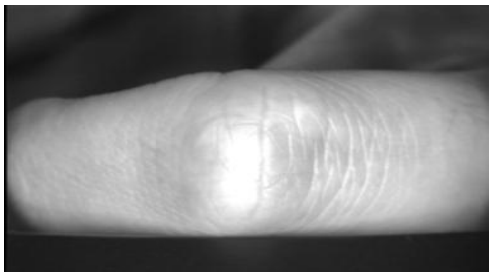


Figure1: Finger Knuckle Print Database [7]

2. EXISTING SYSTEMS
The finger knuckle print identification system is a newly developed biometric identification system. It is based on features of the finger knuckle, texture and uniqueness of lines visible when the finger is folded. The research in [6] is based on combination of local-local information for an efficient finger-knuckle-print (FKP) based recognition system. Local information of the FKP are extracted using Scale Invariant Feature Transform (SIFT) and SpeededUp Robust features (SURF) and they are fused at matching score level. The system is evaluated for various scales and rotations of the query image. It is observed that the system performs with CRR of atleast 98:62% and EER of atmost 5:25% for query image down-scaled upto 60%and performs with CRR of 99:75% and EER of 0:925% for any orientation of query image. It only focuses on the local features.

In [12] DAISY descriptor is implemented to get the features for the finger knuckle print based authentication. The score level fusion technique is used to combine the scores of individual FKPs obtained using the DAISY features. It pays attention only towards the feature extraction methods not on the efficiency of the information retrieval [12].

The authors in [15]ha**s** proposed method that is a hybrid feature selection method of Lempel-Ziv Feature Selection and Principle Component Analysis is used for feature extraction and an artificial Neural Network based on Scaled Conjugate Gradient is used for the recognition. This process is very rigorous and time consuming. As it makes use of artificial neural science it requires lot of training samples and time.All these above methods only provide implementation of finger knuckle print recognition system

using different methodologies but no comparison of these are done with respect to other methods. Due to this the efficiency of these different methods are not known [15].

The authors in [4] had extracted the FKP features using using Kekre'sWavelet and Haar Wavelet transform.TAR-TRR analysis is performed forboth Kekre‟s Wavelets and Haar Wavelet based feature vector on the database. Euclidian distance based classification was used, it wasfound that Haar Wavelets and Kekre‟s wavelets give same Equal Error Rate (EER) of 80% for True Acceptance Rate (TAR) Vs.True Rejection Rate (TRR) analysis. The EER for FalseAcceptance Rate vs. False Rejection Rate (FRR) was found to be 20% [4].

3. HYBRID WAVELETS

Wavelets are mathematical tools that can be used to extract information from many different kinds of data, including images. To analyse data fully sets of wavelets are needed. A set of "complementary" wavelets reconstructs data without gaps or overlap so that the deconstruction process is mathematically reversible and is with minimal loss. The wavelet transforms in many applications are proven to be better than respective orthogonal transforms. This paper proposes the generation of hybrid wavelets type I and type II by combining any two orthogonal transforms like Kekre transform, Walsh Transform, Hartley Transform, Haar and Discrete Cosine Transform (DCT) to obtain the feature vectors. Hybrid wavelet transform acquires the positive characteristics from both the orthogonal transforms used to generate it. The hybrid wavelet transforms are more effective than single orthogonal transforms was proved in different studies and researches [10, 22, 23, 24, 25].

3.1 Hybrid Wavelet Type I

In Hybrid Wavelets Type I (HWI) the image is divided intoLL (Low Frequency), LH (Horizontal), and HL(Vertical), HH(Diagonal) components in the first level. Hybrid Wavelet I has nonstandardcomponents size, this is because of the Nature of the Hybrid Wavelet Matrix, The LL component size is decided by the Low Frequencycomponent of the Wavelet Matrix, in case of the Hybrid Wavelets the Low frequency components is first M rows of the M X P size matrix (first 64 Rows in case of 256 X 256 (64X4) Size Matrix). In case of other wavelets this is exactly half the size of the matrix. This gives different sized components. Wavelet energy based feature vector is generatedfrom these components, generated up to 4 levels [18, 19, 22, 23].

3.2 Hybrid Wavelet Type II

As discussed in [18], the Hybrid Wavelet Type I have limitation of Reduced size of LL component. Hence we have to go for combined Decomposition Based Multi Resolution Analysis. To overcome this problem Hybrid Wavelets Type II (HWII) are proposed by Dr. Kekre. Here the same method discussed in [21], Only change is that, while generating the Low Frequency Component we are repeating the multiplication N Times, Hence the LL component has the size of MXN [18,19,22,23].

4. PROPOSED SYSTEM

Figure.2 shows the proposed system. It has been identified recently that the different patterns on the finger knuckle of a person remains same for his lifetime and they are unique features. These features can be exploited in order to design a new biometric system. This trait is being explored by using different methods such as DAISY descriptor, fuzzy systems, neural systems etc. The idea proposed in paper is the implementation of Finger knuckle print identification using Kekre's Hybrid Wavelet transform type I and type II. This hybrid wavelet transform is new and promising methodology for image processing. Wavelet energy of the FKP Region of Interest for verification purpose will be used. The hybrid wavelet transform were used for combining the traits of two different orthogonal transforms. This helps to exploit the strengths of both the transforms. Here different transforms were used for feature vector generation and compared.

4.1 User Enrollment

TypicalKnuckle-Print image is shown in Figure. 1, taken from the PolyUFKP database. Researchers at Hong Kong PolyU University havedeveloped scanner for FKP [7].

4.2 Image processing

Finger is always put in bending position on the finger supporter when the FKP image is captured, the bottom boundary of the finger which is on the supporter is stable every time and can be taken as the *X*-axis of the region of interest now allocate the *Y*-axis in the center of the phalangeal joint because most of important features are centered in that area .The line features on the two sides of the phalangeal joint turned (u shaped) in different direction [7].

4.3 Feature Extraction

The finger knuckle features were extracted using Hybrid wavelet type I and type II. Hybrid Wavelets were generated using combination of Kekre transform, Walsh Transform, Hartely, DCT &Haar transform. Different combinations of transforms were used for generation of Hybrid Wavelets. Final step is to analyze the performance of the proposed method for biometric authentication.

4.4 Classification

This paper classifies the FKP in two categories namely Accepted & Rejected. The captured FKP were processed to extract the feature vectors. The extracted feature vectors was used for matching the FKP in the database. The matching scores were used for classification of the FKP. A Euclidian distance based KNN classifier was used to recognize the person's FKP and distance probability was plotted using feature vector coefficients.

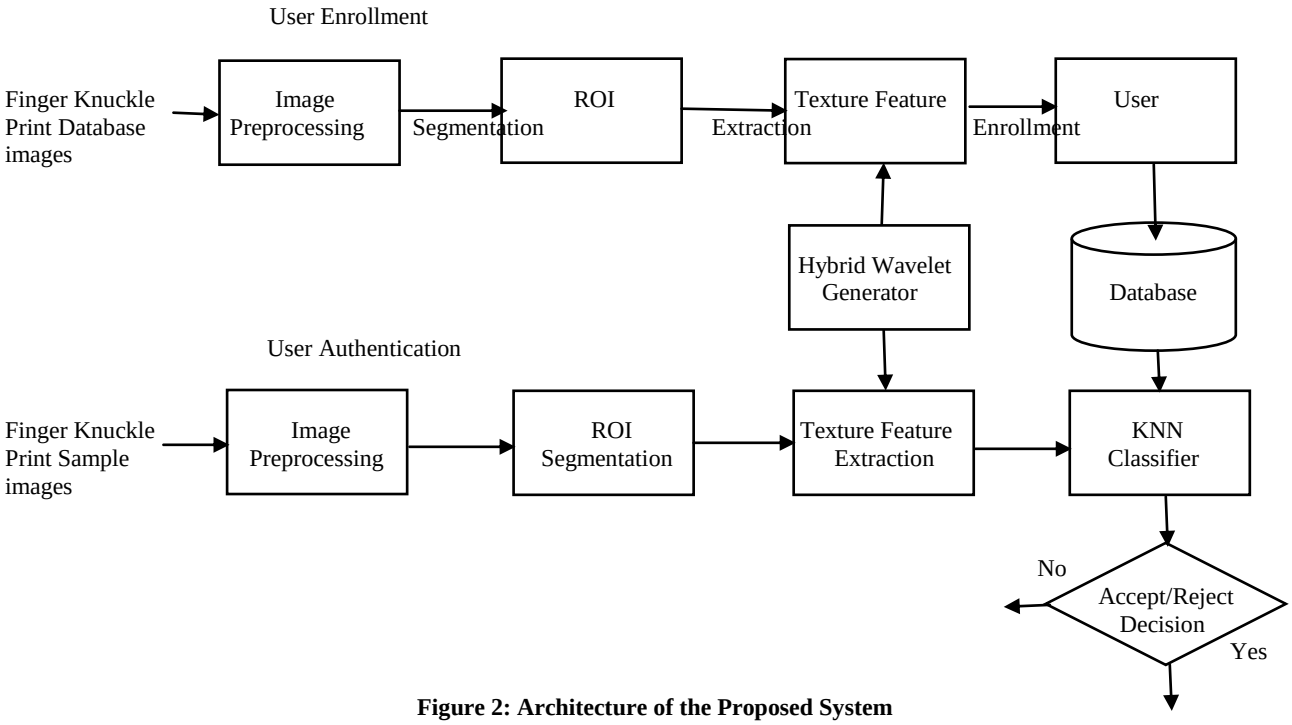
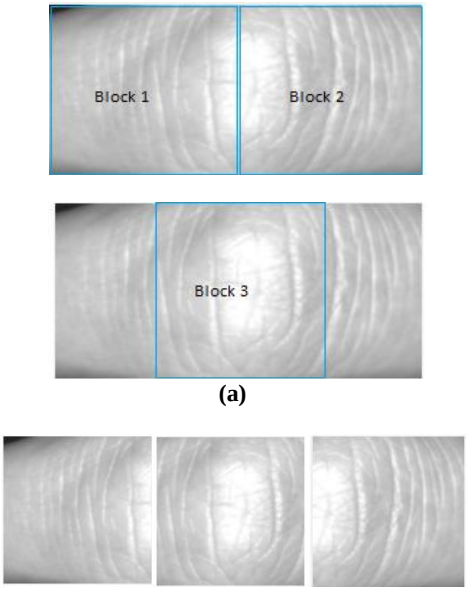


Figure 2: Architecture of the Proposed System

5. FEATURE VECTOR EXCTRACTION USING HYBRID WAVELETS TYPE I AND TYPE II

The original database Finger Knuckle Print image is preprocessed to obtain a Region of Interest (ROI) of dimension 256x128.



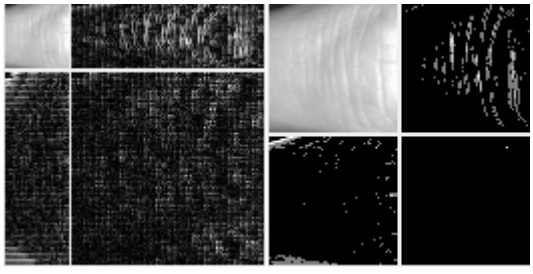
(a)

(b)

Figure 3: (a) Division of FKP into three blocks (b) Three blocks of FKP

This ROI is further divided into three blocks as left, center and right of dimension 128x128 each as shown in Figure 3[4]. Hybrid Wavelets type I and type II generated using different combinations of Kekre, Walsh, Haar, DCT, Hartley transforms were applied upon each individual blocks. This generates 5x4 i.e 20 hybrid wavelets for each block. The hybrid wavelets are applied on the images to perform Multi Resolution Analysis (MRA).

Multi Resolution Analysis approach was used to generate 4 levels of Wavelet Energy based feature vector extraction. One example of wavelets generated from HWI and HWII are shown in Figure 4. Each component is divided into 4x4 (SxS) non overlapping blocks; hence for a single component (LH, HL or HH) we have 16 wavelet energy values. In a single decomposition we have 3 hence we get total 48 values in one level of decomposition.



(a) **(b)**

Figure 4: (a) Hybrid Wavelet I Components of FKP block(b) Hybrid Wavelet II Components of FKP block

These energies reflect the strength of the images' details in a different direction at the level decomposition. Hence the feature vector where K is the total number of wavelet

decomposition level, can describe the global details feature of FKP images. Such 4 levels are considered for the current scenario, hence total 192 values in one feature vector. These feature vectors thus obtained are plotted into graph format as shown in Figure 5 and 6 which shows Multi Resolution Analysis of user 1 for HWI and HWII [4,8,9,17,18].

6. RESULTS.

The resulting graphs shows an example of plotting of the Feature Vector coefficients of the different combinations of transforms forming the hybrid wavelets.

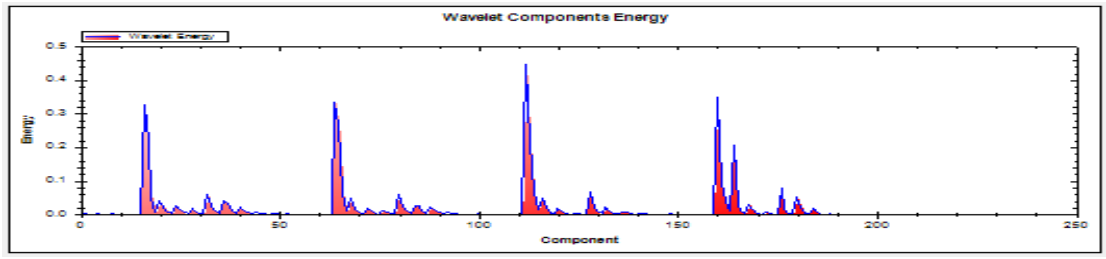


Figure 5. Multi Resolution Analysis of HWI using Kekre and Walsh transform

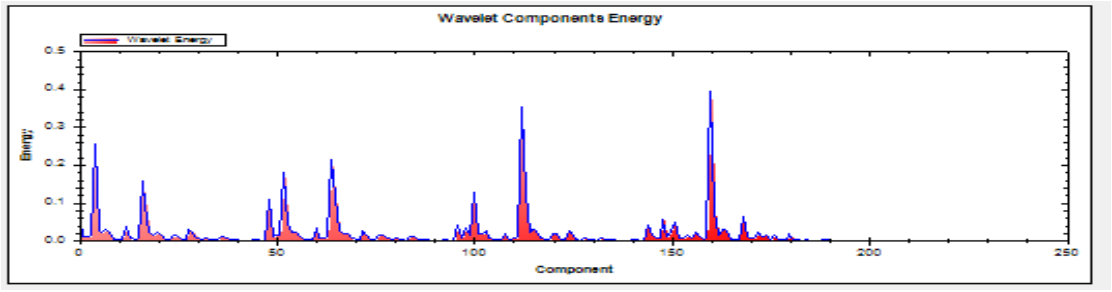


Figure 6. Multi Resolution Analysis of HWII using Kekre and Walsh transform

The POLYU FKP [7] database was used for testing this method.The testing code is written in Microsoft Visual C# 2013 (.NETFramework 4.0). The feature vector extracted using Hybrid Wavelets were worked upon by Euclidian distance K Nearest Neighbour algorithm to study the distance probability.The intra-class and inter-class matching is performed on the database. The intra class testing is evaluating the distance between samples of same user and inter class testing is evaluating the difference between samples of different users. This willbe used to analyse genuine and imposter identification capabilityof the FKP based verification. The distance of the Feature Vectors obtained using Hybrid Wavelet I and Hybrid Wavelet II for Genuine FKP matching (Intra-class) andimposter (Forgery) FKP matching (Inter-class) with theprobability of occurrence is shown in Figure. 7 and Figure 8. The graph clearly shows that inter class distance is greater than intra class distance.

7. CONCLUSION

This paper proposes to combine different transforms to obtain hybrid wavelet type I and type II. These wavelets were used to generate MRA which gives feature vectors. The intra class and inter class distances were studied using distance probability. We had concluded that-

- The inter class distances are more than inter class distances in both the wavelets type I and type II that clearly distinguishes genuine and forged samples.
- The proposed paper also shows that the inter class and intra class distances were more prominent in hybrid wavelet type II than in type I.

In Future the multi-Instance and Multi-Algorithmic analysis can be done on the values of the feature vector obtained for more detailed comparison and analysis.

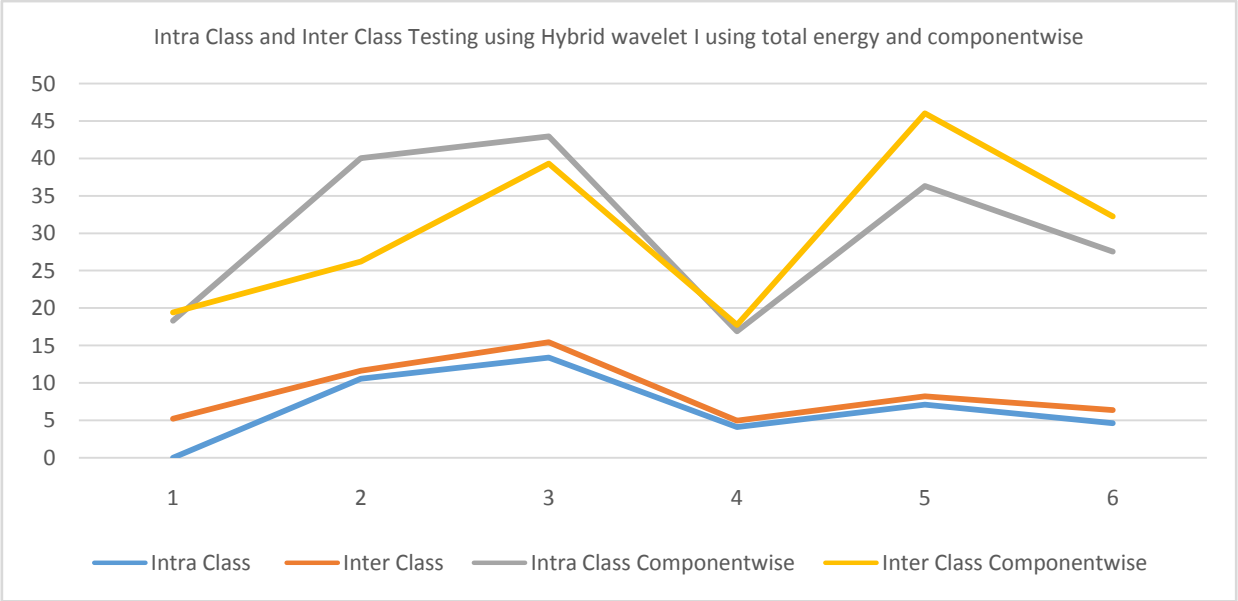


Figure 7. Distance Probability of intra and inter class using Hybrid Wavelet Type I

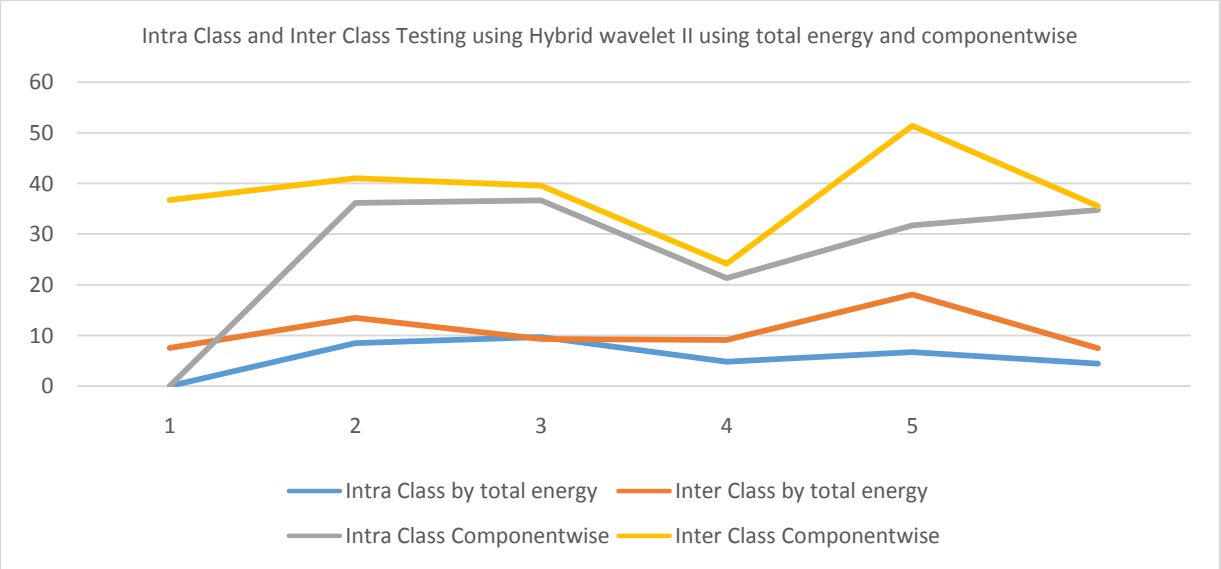


Figure 8. Distance Probability of intra and inter class using Hybrid Wavelet Type II

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