Palmprint Biometric for Personal Authentication

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ABSTRACT
Biometrics refers to technologies that measure and analyzes human body behavioral characteristics such as fingerprints, palmprint, knuckles, hand geometry hand vein, retinas, irises and physiological characteristics such as gait, signature, key stroke etc. for authentication purposes. The palmprint is emerging biometric with the advantages of large Region of Interest (ROI) and chances of damages are very rare. In biometric based authentication decision tree is used for the classification of genuine and imposter classes. If the data is noisy, decision tree leads to false branches called over-fitting of the tree. This requires pruning of tree which will lead to decrease in performance. For that Fuzzy Decision Trees (FDT) is developed for classification of claimed identity into two classes genuine and imposter, hence it termed as Fuzzy Binary Decision Tree (FBDT). Fuzzy gini index and fuzzy entropy is used for selection of tree nodes. Matching training scores are used for automatic generation of fuzzy membership functions.

Keywords
Decision tree (DT), Fuzzy binary decision tree (FBDT), Mean-index, Splitting criteria, Fuzzy membership functions, Fuzzy entropy, Fuzzy Gini index. Keywords are your own designated keywords which can be used for easy location of the manuscript using any search engines.

1. INTRODUCTION
Physiological and behavioral traits of human are used for personal authentication by biometrics. Biometric systems [3] is used for pattern recognition which obtains the data from each person and pulls out the needed set of feature from acquired data and compare that set of features with the database feature. Normally, biometric is stepwise procedure. First, the sensor module captures the characteristics of human and converted into digital image. Second, the feature extraction module extracts the needed features from the digital image and saves as a template for each user. Third, the matching module compare the claimed user template with stored template and it also provide the matching scores of genuine and imposter. Fourth, the decision module determines whether the claimer user is genuine or imposter based on matching scores.

Palmprint recognition system is an authentication mechanism that relays on identification and verification of an individual based on unique palmprint. Verification is a comparison of the one to one biometric sample with the reference template on file. Identification makes a one-to-many comparison to determine a user's identity.

A palmprint measures the features of the palm to identify the person. Palmprint based biometric authentication system has been used by many people. The main types of features in the palmprint are principal lines, wrinkles and creases. The heart line, life line and head line are the three principal lines. These principal lines are vary over time in little amount. Wrinkles are lighter than principal lines. Creases are detailed textures, like the ridges in a fingerprint, all over the palmprint. Creases can only be captured using high resolution cameras. But other than creases, the principal lines and wrinkles are captured using low resolution cameras. With the low resolution palmprint image, the principal lines and thick wrinkles will be exploited for verification.

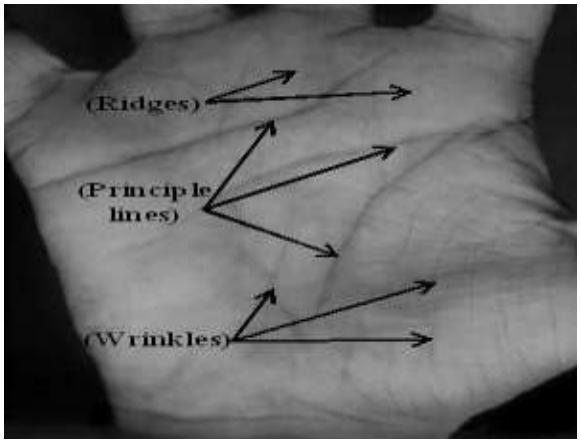

Figure 1. Palmprint features

Palmprint provides as a reliable human identifier because the print patterns are not found to be duplicated even in monozygotic twins. Furthermore, it is reported that a system based on hand features is most acceptable to users. The features of the human hand are relatively stable and unique. Compared to other biometric systems, the advantages of using palmprint based biometric system can be multi-fold. The features of the human hand are relatively stable and unique. It needs very less cooperation from users for data acquisition. Thus palmprint is expected to have wide range of potential security applications such as access control, network security and social security. Non-intrusive data will lead to low performance. The devices with low cost are sufficient to acquire data with good quality. Pin markers are installed between fingers to enable good quality of image acquisition.

False Acceptance Rate (FAR) and False Rejection Rate (FRR) are used for evaluation of performance of biometric trait. By comparing the matching scores with the decision threshold performance is evaluated. Receiver Operating Characteristics (ROC) curve is used for determining the False Acceptance Rate (FAR) and False Rejection Rate (FRR).We can also use the classifiers for determining thresholds. Detection Error Tradeoff curve and Cumulative Match Characteristic are also used for the evaluation of biometric traits. DET curve is modified ROC curve.

2. RELATED WORK

One of the popular methods used for the classification in data mining is decision tree. Now, decision tree is used in several biometric applications. NNM, SVM, bayes, FNN [10] is compared with Decision Tree. If the training data has independent value and the output value is numerical means the logistic regression classifier is perform well. The data which is used for training is redundant means it leads to degradation of performance. If the data is noisy and erroneous or with ambiguity and vagueness means a perfect separation of genuine and imposter classes are not possible in Decision Tree. DT produce false branches called over fitting of the tree which lead to high error rates. So, it requires pruning of the tree which will increase computational complexity.

The block diagram of FBDT explains about modules. First, the feature extracts from training and testing image using Otsu method in feature extraction module. And from that image texture of the image is extracted using Gabor filter. Second, matching scores is calculated by using Euclidean distance measure. Then Gaussian membership function is used to find membership values from matching scores. Third, the decision is constructed for membership values by defining splitting and stopping criteria. Fourth, the claimed identity image is tested to check whether the image is genuine or imposter.

3. FUZZY BINARY DECISION TREE

The main objective is to classify the claimed identity as genuine or imposter without any performance deterioration. To overcome the performance degradation Fuzzy Decision Tree (FDT) is used. Classification of training data into two classes as genuine and imposter by FDT. So FDT is termed as FBDT.

3.1 Feature Extraction

3.1.1 Otsu Method

In Image processing and computer vision, Clustering based image thresholding is performed by using Otsu's method or to convert the graylevel image to a binary image. The algorithm divides the image into two classes based on each image. For each image Otsu method set the threshold and convert that image into black and white. Multi Otsu method is the extension of Otsu method which is used for multi- level thresholding. Otsu's thresholding method involves iterating through all the possible threshold values and calculating a measure of spread for the pixel levels each side of the threshold, i.e. the pixels that whichever falls in foreground or background. The aspire is to locate the threshold value where the sum of foreground and background spreads is at its minimum.

3.1.2 Region of Interest (ROI) Extraction

ROI extraction plays an important part in image processing and analysis. Firstly, a rough ROI was determined based on the previous knowledge. Then the edge, intensity, location of the marked ROI are the low level features combining with an information table reflecting the relation of classification was constructed and the basic regions were built. The approximate region which is extracted from the original rough ROI was considered as the final ROI. Otsu method has higher accuracy and lower time complexity than the traditional methods. Centroid of the black and white image is calculated. From that centre point, extract the image upto 40 degree in x and y axis. Then the interested feature for the image is extracted.

3.1.3 Gabor Filter for Texture Extraction

Gabor filter in image processing is given by Dennis Gabor. Gabor filter is linear filter which is used for edge detection. Orientation and frequency is similar to the human visual system in Gabor filters. Also discovered that simple cells in the visual cortex of mammalian brains can be modeled by Gabor functions. The image analysis is similar to perception in the system by the Gabor functions. Gabor features extract local pieces of information which are then combined to recognize an object or region of interest. The texture of the image is extracted by using Gabor filter. By using low resolution camera the wrinkles and creases are not appear clearly. When we use high resolution camera it is able to obtain all the features of palmprint. Gabor filter is apply to the image captured by low resolution to obtain the texture of the image.

3.2 Fuzzy Membership Function

A membership function describes degree of membership of a value in a fuzzy set. Fuzzification means crisp inputs x, y and determine the degree to which these inputs belong to each of the appropriate fuzzy set. The membership functions used for fuzzification may be Triangular, Gaussian, and Trapezoidal etc. Matching scores are calculated by using Euclidean distance. The distance between two points a and b in the Euclidean is the length of the line segment connecting them. In Cartesian coordinates, if $a = (a_1, a_2 \ldots a_n)$ and $b = (b_1, b_2 \ldots b_n)$ are two points in Euclidean n-space, then the distance from a to b, or from b to a is given by

$$d(a,b) = d(b,a) = \sqrt{\sum_{i=1}^{n} (b_i - a_i)^2} \quad (1)$$

In Fuzzy binary decision tree, Membership function is used to fuzzify the matching score. The matching scores which is calculated from Euclidean distance is classified as training and testing. If the matching score is calculated between samples of same person from both training and testing, then that matching score is referred to as genuine. Likewise, if the matching score is calculated between samples of different person from both training and testing, then that matching score is referred to as imposter score. Minimum score from same person is taken as matching score for that person. The mean indices are calculated from the membership values and used for the determination of tree-nodes splitting criteria. For the fuzzification of the matching scores, a proper choice of membership functions is necessitated and for the splitting criteria, both fuzzy Gini index and fuzzy entropy are considered.

Membership functions are chosen such that their parameters should cover the range of the scores and the scores nearer to the cluster center of a class should have the large membership values. Since the biometric applications require an automatic authentication whenever a new user is enrolled, i.e. his/her data loaded, an easy computation of the membership values is all the more important. There are any Membership functions like Gaussian, trapezoidal, triangular are available to fuzzify the value. Mean and variance are easy to obtain from the matching scores which is used by the Gaussian membership function. Let θ denote the mean and σ denote the Standard Deviation (SD) of the matching scores. Assuming the range of the matching scores as [a, b], the Gaussian membership function for a score x is given by

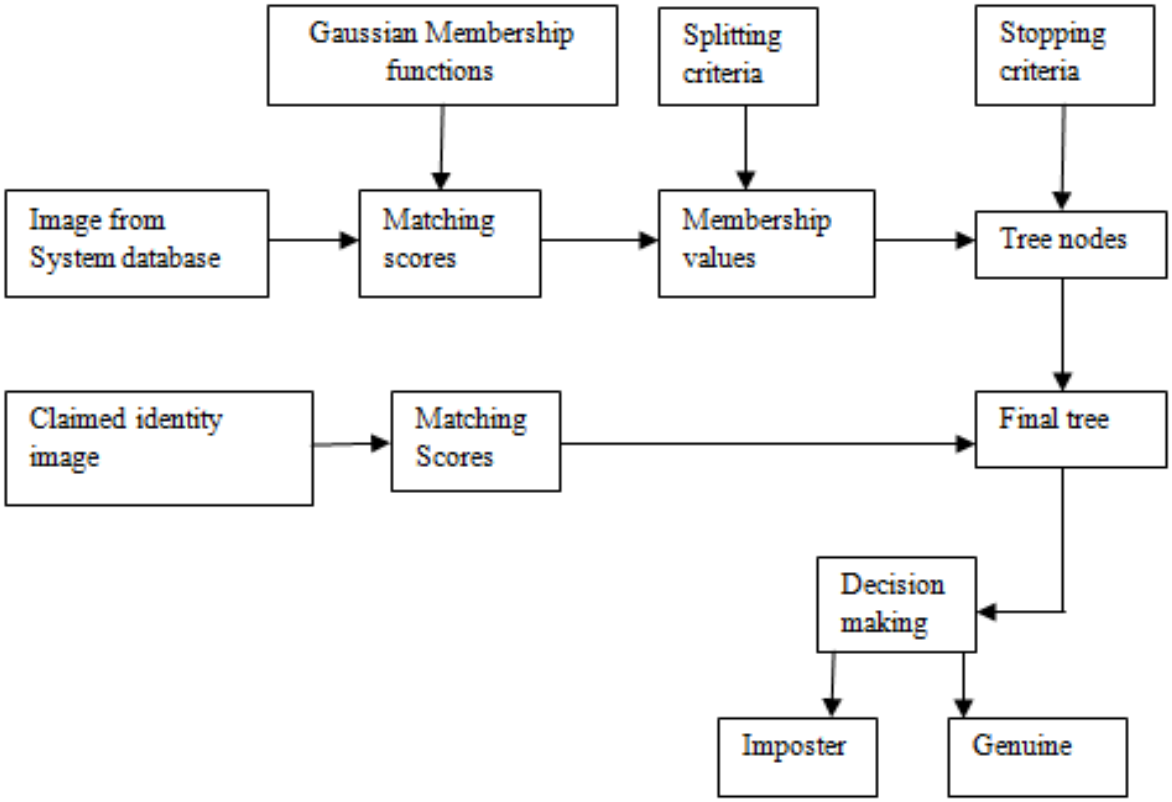

Figure 2 Block diagram of FBDT

$$F(x) = \exp\left\{-\frac{(x-\theta)^2}{2(\sigma)^2}\right\} \text{if } a < x \leq b = 0 \quad (2)$$

3.2 Decision Tree Construction

Fuzzified membership values by Gaussian functions are used for the construction of tree nodes. The mean-indices are derived from the membership a value of the matching scores is used for partitioning the attributes. For the creation of the decision tree, we want to define the splitting and stopping criteria. When one node satisfies the stopping criteria that node is defined as leaf node. Leaf node is the class label for the tree which determines whether the claimed identity is genuine or imposter. The splitting criteria are calculated for each mean- index to select the tree-nodes. In FBDT the stopping criterion is checked by two thresholds: θ_C and θ_L for every left and right branch-node the following conditions are checked. The Creation of tree nodes stopped when the sum of the membership values of a class C_m for m=1, 2 is greater than or equal to θ_C and whether the sum of the membership values of all the scores is less than the threshold value.

3.3 Palmprint Verification

For the testing samples also the features are extracted and the matching scores are computed and fuzzified using Gaussian membership function. Then the fuzzified matching score is given as input for the decision tree and check whether the testing sample is genuine or imposter.

4. EXPERIMENTAL RESULTS

To evaluate the performance of FBDT, the Receiver Operating Characteristics (ROC) curve in MATLAB is used. PolyU_palmprint_database [8] which contain images of 386 persons. Each person have 20 images (10 images taken at first session, another 10 images at second session).So the total image in database is 7720. The performance of FBDT is determined by using False Acceptance Rate (FAR) and False Rejection Rate (FRR). The false acceptance rate or FAR is the measure that accept unauthorized user as authorized user. FAR is calculated by the ratio of false positive by addition of false positive and true negative. The false rejection rate or FRR is the measure of the biometric system will reject the authorized users by thinking it as unauthorized users. FRR is calculated by

$$FAR = \frac{FP}{FP + TN} \quad (3)$$

$$FRR = 1 - FAR \quad (4)$$

Figure 3. First block is original image, Second block is ROI image, Third block is Texture of image

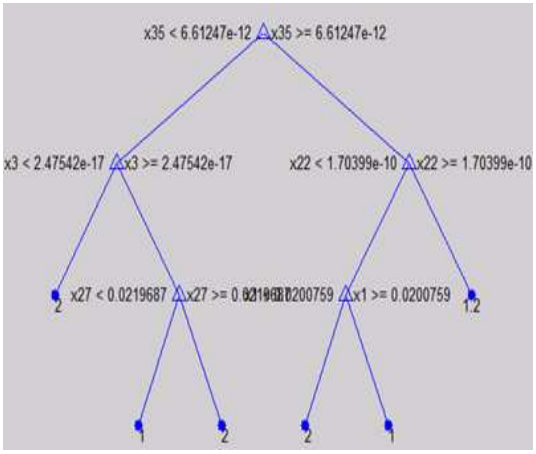

Figure 4. Decision tree for the trained data

TABLE 1. Performance of FBDT with Other Classifiers

Classification Techniques	FAR	FRR
PNN	0.005	4.542
SVM	0.002	5.827
DT	0.004	6.025
FBDT	0.005	3.027

5. CONCLUSION

FBDT is proposed for palmprint biometric based authentication. The FBDT embarks on the perfect classification of the claimed identity into either genuine or impostor classes. The FBDT is created using the membership values, which originate from the matching scores. Here the Gaussian membership functions are used for the fuzzification. This approach permits the automatic computation of the membership values of the matching scores paving the way for the determination of the tree-nodes in the FBDT with the enrolment of the new users in the database. The trained FBDT has significantly less size and yields very low error rates in comparison to its crisp counterpart, DT. The accuracy of FBDT can be improved by exploring the fuzzy based technique in multimodal biometrics system with help of optimization algorithm.

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