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Estimation of Age from Fingerprint using KNN Classifier Algorithm

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Abstract: Skin on human fingerprints contains ridges and valleys which further form distinctive patterns. These patterns are called fingerprints. The intensive research on fingerprints show that they are distinguished by a feature called Minutiae. The minutiae are the ridge endings or bifurcations on fingerprints. They, including their coordinates and direction, represent the finger prints. Almost all fingerprint recognition system holds only the minutiae template in the database for further usage. The proposed system determines the age using image processing techniques by KNN classifier algorithm. The system has a method to restrict children from accessing adult sites in web browsers by age classification methods. The method comprises pre-processing stages and age classification. The preprocessing stages incorporates Binarization, Ridge thinning, finding minutiae, eliminating false minutiae, Region of Interest (ROI), orientation. The age classification includes minutiae exportation and feature extraction, which is further subjected to age classification using the KNN algorithm. The KNN algorithm is the K Nearest Neighbor algorithm which, in first finds the nearest neighbor and finds the distance between the training sets and query instance using the Euclidian distance method. By finding the shortest distance of the ridge, the age is estimated and they are restricted from harmful sites, if under 18 years. Also, detecting age from already available fingerprints may pave way to many future technologies like blocking unwanted television channels for children below 18 and for forensic purpose.

Key words: K Nearest Neighbor algorithm (KNN) · Region Of Interest (ROI) · Minutiae · Binarization · Ridge Thinning · Euclidean Distance Method(EDM · Forensic · Fingerprint Enhancement

INTRODUCTION

Fingerprints are widely used in all forms of applications for security purpose and they are mostly used in biometric identification. Fingerprint identi?cation has been commonly employed in criminal investigations and in biometric systems such as attendance monitoring, commercial identification devices. The fingerprint of an individual is unique and remains unchanged over a lifetime. Fingerprints are formed from an impression of the pattern of ridges and valleys on a finger. A ridge is defined as a single curved line and a valley is the region between two adjacent ridges. The minutiae, which are the local points in the ridge flow pattern, provide the features that are used for identification. Details such as the type, orientation and location of minutiae are taken into account when performing the minutiae extraction. The set of minutiae types is restricted into two types such as ridge endings and bifurcation points. Ridge endings are the points where the ridge curve terminates, two ridges come together at a point called bifurcations and bifurcations are known as minutiae. It is useful to divide bifurcation into two classes. Local bifurcations and Global bifurcations. Local bifurcations, which can be analyzed entirely through changes in the local stability properties of equilibria periodic orbits or other invariant sets as parameters cross through critical thresholds; and Global bifurcations, which often occur when larger invariant sets of the system 'collide' with each other, or with equilibria of the system. They cannot be detected purely by a stability analysis of the equilibria (fixed points). Fingerprint raw images are rarely of perfect quality. They may be degraded and corrupted due to a certain amount of noise present in the image. This degradation can result in a significant number of false minutiae being created and genuine minutiae being ignored. Thus, it is necessary to employ image enhancement techniques prior to minutiae extraction to obtain a more reliable estimate of minutiae locations and to obtain an enhanced fingerprint image.

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Existing System: In [1], Impact of Age Groups on Fingerprint Recognition Performance, 2007, Shimon K. Modi, Prof. Stephen J.Elliott, Ph.D., Jeff, 2007, IEEE Transactions on Information Forensics and Security. This paper examines the effects of fingerprints from different age groups on quality levels, minutiae count and performance of a minutiae-based matcher. The approach used is a Box plot of Minutiae Count Across Age Groups. The result achieved show a difference in fingerprint image quality across age groups, most pronounced in the 62-and-older age group. Drawbacks of this paper is Error rates are amplified when a fingerprint recognition system is deployed for large-scale use by subjects from different age groups.

In [2], Age Classification System Anchored in Fingerprint Minutiae Extraction, S. Sudha Ponnarasi *et al.*, 2012, European Journal of Scientific Research. Aim of the paper is to extract features from finger print like ridge count , ridge width , ridge thickness to valley thickness ratio (RTVTR), white lines count and ridge count asymmetry and pattern type concordance. The approach for age classification Neural Network (NN) was used for the classification using the most dominant features. Result achieved in the paper is features were extracted from finger prints and age was classified using neural network classifiers. Drawback of the paper is the success percentage of the age detection is very low.

In [3], Estimation of Age Through Fingerprints Using Wavelet Transform and Singular Value Decomposition Binarization International Journal Biometrics and Bioinformatics (IJBB), Volume (6): Issue (2): 2012 . Aim of the paper is the Feature extraction using SVD and DWT and determing age using KNN classifier. The approach is based on determing Frequency Feature Extraction using DWT, spatial feature extraction using SVD, fusion of features extracted takes place and age estimation using KNN classifier. The result obtained is based on DWT and SVD also applied to classify the fingerprints in to the five age groups. Exact estimation of age group is achieved for the age group below 12 years. The drawback of the paper is that age group of 36 and above the success rate is not reasonably good. Number of samples taken in each category is less, so accuracy for age estimation is less.

In [4], Fingerprint Image Enhancement and Minutiae Extraction International Journal Biometrics(IJBB), Volume (9): Issue (4): 2009 Raymond Thai In this paper, they firstly provide discussion on the methodology and implementation of techniques for fingerprint image enhancement and minutiae extraction. Experiments using a mixture of both synthetic test images and real fingerprint images are then conducted to evaluate the performance of the implemented techniques. In combination with these techniques, preliminary results on the statistics of fingerprint images are then presented and discussed.

In [5], Fingerprint Classification by Directional Image Partitioning, Raffaele Cappelli, Alessandra Lumini, Dario Maio, Member, IEEE and Davide Maltoni, IEEE transaction on pattern and machine analysis VOL 21, Issue 5, May 1999—In this work, we introduce a new approach to automatic fingerprint classification. The directional image is partitioned into “homogeneous” connected regions according to the fingerprint topology, thus giving a synthetic representation which can be exploited as a basis for the classification. A set of dynamic masks, together with an optimization criterion, are used to guide the partitioning. The adaptation of the masks produces a numerical vector representing each fingerprint as a multidimensional point, which can be conceived as a continuous classification. Different search strategies are discussed to efficiently retrieve fingerprints both with continuous and exclusive classification.

In [6], Fingerprint Classification Based on Learned Features, Xuejun Tan, Bir Bhanu, Fellow, IEEE and Yingqiang Lin, IEEE Transactions on systems, man, and cybernetics=part c:applications and reviews VOL.35, NO3, AUGUST 2005, In this paper, they present a fingerprint classification approach based on a novel feature-learning algorithm. Unlike current research for fingerprint classification that generally uses well defined meaningful features, this approach is based on Genetic Programming (GP), which learns to discover composite operators and features that are evolved from combinations of primitive image processing operations. their experimental results show that this approach can find good composite operators to effectively extract useful features. Using a Bayesian classifier, without rejecting any fingerprints from the NIST-4 database, the correct rates for 4-and 5-class classification is 93.3% and 91.6%, respectively, which compare favorably with other published research and are one of the best results published to date.

In [7], Fingerprint Based Gender Classification Using 2D Discrete Wavelet Transforms and Principal Component Analysis, Rijo Jackson Tom1, T. ArulkumaranInternational Journal of Engineering Trends and Technology- Volume4 Issue2- 2013. This paper aims in using 2D-Discrete Wavelet Transform (DWT) and Principal Component Analysis (PCA) combined to classify gender using an obtained fingerprint. The minimum distance method was used as a classifier. Fingerprints of 200 males and 200 females belonging to

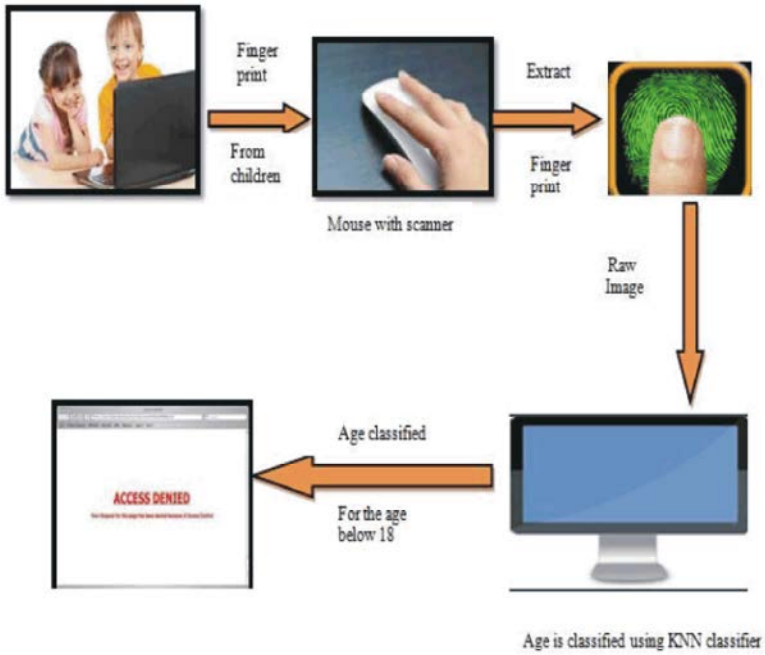

Fig. 1: System Architecture

the various age groups were taken for analysis. The experimental results show good for trained database. It was found that increasing the database population in each category improves the performance of the system.

Proposed System: The Main aim of the proposed system is to determine and classify age using KNN classifier. For this purpose, the fingerprint data set is taken and fingerprint is enhanced using fingerprint image enhancement process. The enhancement process incorporates many preprocessing stages which makes the fingerprint image clear and noise free.

When the users, especially children under 18 years browse for any information on websites, there is a chance of misguiding them to harmful web pages. In order to safeguard them, this system has been proposed. When the children use the mouse to surf, their fingerprint will be scanned automatically with the help of the mouse embedded with the fingerprint scanner. The enhancement of this raw image will be processed. After the enhancement process, the image will be subjected to determination of age using the KNN classifier algorithm. Once, when the age is determined, if the, found age is under 18 years, the system will automatically generate an Access Denied alert. Therfore, the prevention from visiting restricted sites can be done effectively by this proposed system.

The complete proposed system is divided into four modules as shown in Fig. 2.

- Data Collection
- Image Enhancement
- Minutiae Extraction
- Age Classification

Module 1: The overall proposed system is initiated by collecting the required fingerprint Datasets of all age categories. The data either can be maintained in a database or it can be taken live from the fingerprint scanner embedded in the mouse.

Module 2: The Image Enhancement Process has three sub-processes , they are Loading, Binarization and Image thinning. The raw image from the scanner is loaded as input and further subjected to binarization and thinning process. As a result an enhanced image is produced.

Module 3: The thinned image is given as input and the image is analyzed to find minutiae in it. This process creates false minutiae which has to be removed. Henceforth, the next step is to remove the false minutiae and Region Of Interest (ROI) is determined to which the minutiae are to be calculated. The minutiae are oriented to the ROI area and it is matched with the template available. The count of minutiae feature is exported and finally the feature is extracted.

Module 4: Age classification is done using KNN Classifier based on the fingerprint minutiae feature extraction. Simulation for website access restriction is made based on the age classified using KNN classifier. The system has a method to restrict children from accessing adult sites in web browsers by Age Classification Methods. The system increases the success rate around by 2 %.

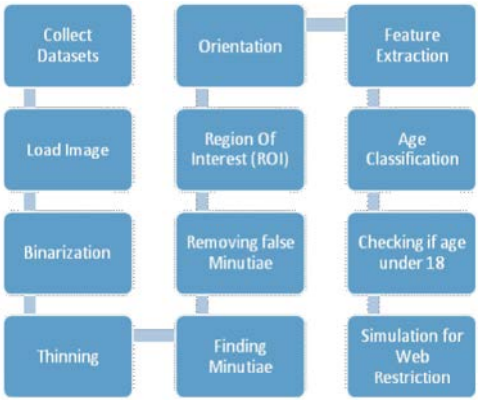

Fig. 2: Image Enhancement (left column), Minutiae Extraction (middle), Age Classification (right column)

KNN Classifier: The KNN classifier algorithm is used for classifying age based on minutiae count. The steps of the KNN classifier algorithm are as follows,

Algorithm:

- Input: all samples of fingerprint with known class (Gender)
- Output :age classified into categories
- Determine the parameter K = number of nearest neighbors beforehand.
- Calculate the distance between the query-instance and all the training samples. This is done by Euclidian Distance Method.
- Sort the distances for all the training samples and determine the nearest neighbor based on the K-th minimum distance.
- Since, this is supervised learning, get all the Categories of our training data for the sorted value which fall under K.
- The majority of nearest neighbors is used as the prediction value.

The age is found using the age detection method. System issues command to restrict adult oriented sites to children under 18.

Classification	FAR	FRR	Accuracy
KNN (proposed method)	5.15	0.75	97.80
NN	10.82	2.15	97.47

Fig. 3: Age classification performance analysis

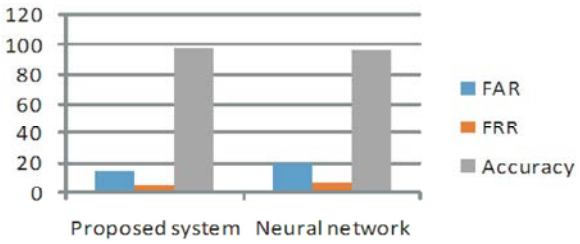

Fig. 4: Performance analysis of KNN algorithm

Experimental Analysis: The performance analysis of the proposed, age determination from fingerprint using KNN algorithm is shown in Fig. 3. The result of the chart shows advantages over the already existing Neural Network.

The Figure 4, Shows the comparison between the proposed and other neural networks. The False Acceptance Rate (FAR) and False Rejection Rate (FRR) is analyzed to be low comparatively to the existing system. Thus increasing the accuracy by 0.33% , holding an accuracy of 97.80%, whereas the existing neural network shows 97.47% accuracy.

CONCLUSION

The existing scheme addresses the complexity in determining age from fingerprint using perplexed mathematical calculations and it produces a very low success rate for various age groups. To overcome this, the proposed system uses K Nearest Neighbor algorithm to classify the age from the fingerprints. The results confirm a difference in fingerprint image quality across age groups. The proposed method gives more accuracy and also the false acceptance, rejection rate is less compared to other methods.

Future Work: Future works includes such as protecting children from online sites that are harmful by embedding fingerprint scanner in mouse. Detecting age from already available finger prints may pave way to many future technologies like blocking unwanted television channels for children under 18 by using remote with a fingerprint scanner. This research work can be used by detectives for detecting age from the fingerprint lifted from the site of crime.

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