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Image Analysis using Non Negative Matrix Factorization

PESN Krishna Prasad, K. Pavan Kumar, Y. Suresh

Abstract: ***Image analysis extracts the meaningful information from the images. This information is very much helpful to recognition and authentication. There are number of techniques available for image analysis. Image analysis can be used in analysis of the scene, image understanding and computer vision. Image analysis can be used in Medical image processing, Geology, optical character recognition and forensics. There are mainly four steps in the image analysis 1.image pre processing 2. Segmentation 3.feature extraction and 4. Classification and interpretation. Feature extraction is the main part for any image analysis. In this paper Multi modal biometric authentication system can be defined for security. In this process Non Negative Matrix Factorization (NMF) technique is used for feature extraction and for fusion Principle component analysis is used. After getting the features these can be encoding using Kronecker product. At the end Euclidean distance measure is used for authentication.***

Keywords: ***Non negative Matrix Factorization, Principle Component Analysis and Kronecker Product..***

I. INTRODUCTION

Tensors play a major role in the process of image patterns by considering the concept of approximations by varying orders of polynomials. Tensor defines a natural decomposition of homogeneous patterns that leads the connection between the multivariate polynomials and symmetric tensors, rectification is not possible. Tensors can be written in different forms, for instance multidimensional arrays. Thus tensors are multi-linear objects that express the coefficients of linear combinations in some specific order.

One of the inductive learning concepts is feature selection. The selection of a subset of features from the given list of features is in different ways: 1) by considering an evaluation measure, the subset of features with specified size 2) the smaller size subset features satisfies with certain restriction on the chosen measure and 3) the set with best features among its size and the value of its measure. The main intention of this leaner is to improve the inductive learning process in terms of speed, capacity and representation of the feature patterns.

In the concept of image analysis, feature extraction and selection is one key concept for the selection of best features in order to analyze and represent the patterns through the concept of Tensor objects.

Numerous traditional approaches exists for the extraction of features in the process of image patterns such as Principal Component Analysis (PCA), Sparse PCA, Kernel PCA and its variants, Singular value decomposition (SVD), Sparse SVD, Kernel SVD and its variants, Discriminate Analysis, matrix factorization techniques, Optimization Techniques like Genetic Algorithm, Ant Colony Optimization (ACO) etc. Among these approaches, in the analysis of Tensor features for the classification and recognition, the author has chosen Tensor based Matrix factorization techniques for the extraction and selection of features.

The fundamental concept of Machine Learning is feature selection that identifies most salient features from image patterns, so that the Machine Learning algorithms focuses for the analysis of patterns in view of classification and recognition of the patterns. Feature selection removes the irrelevant features and reduces the dimensionality, increases accuracy and improves the comprehensive results.

Author proposes an intuitive approach for feature selection using Tensor based Feature Selection (TFS) for the analysis features through tensor objects using matrix factorization techniques such as Multi-linear Singular Value Decomposition (MLSVD), Nonnegative Matrix Factorization (NMF), Nonnegative Tucker Factorization (NTF),Multi-linear Principal Component Analysis (MPCA) and Principal Tensor Analysis (PTA).

In the field of Computational streams, scalars and vectors hardly exhaust the class of quantities. There is some sort of quantities with more complex structure than scalars and vectors, of an order 2 or higher often called ***Tensors***, whose specifications are more than the concept of magnitude and direction. In the field of Image Processing, the patterns of images can be represented as an order of 2 or higher for the process of segmentation, dimensionality reduction and analysis of image patterns in terms of classification,

recognition and matching. In this aspect, traditional approaches can be fitted due to consideration of higher order features from the image patterns. Thus, in order to process such patterns tensor based computational strategies to be considered for image pre-processing, segmentation, classification and analysis and also image matching methods. In this article, tensor based feature extraction and selection methods to be considered for the extraction of best features from the image datasets and then analyze such patterns through supervised learning methods such as nearest neighborhood and SVM classifiers.

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* Correspondence Author
Dr. PESN Krishna Prasad*, ,Professor, Dept. of CSE,, Sri Venkateswara College of Engineering, Tirupati, Andhra Pradesh, India. Email: surya125@gmail.com
Dr. K. Pavan Kumar, Asst. Prof, Dept. of IT, PVP Siddhartha Institute of technology, Kanuru, Vijayawada, A.P, India Email: pavankalluri@pvpsiddhartha.ac.in
Dr. Y. Suresh, Asst. Prof, Dept. of IT, PVP Siddhartha Institute of technology, Kanuru, Vijayawada, A.P, India Email: sureshyadlapati@gmail.com

In this paper a new model was proposed for feature extraction as Nonnegative Matrix Factorization, so that the performance of the system can be increased when compared to the existing system. The overall paper can be organized as follows in the next sections. Section II provides the recent pre processing algorithms in the literature. Section III provides the over view of the Non negative Matrix Factorization (NMF). Section IV provides the results and discussion.

II. FEATURE EXTRACTION

Now a day's security is the crucial issue in lot of area like banking, business and enforcement. The main role of the security is the identification. For this identification extracting the features are most important. There are lot of algorithms developed in the literature for this feature extraction. Zaho [1] presents modified binary pattern histogram algorithm based on the pixel neighborhood gray median. It solves the problem of expression variation attitude deflection.

Gulzar [2] identified a new security system for door locking with less cost for automobiles and security. Wasif Khan [3] developed a new feature extraction methodology by integrating various feature extraction techniques.

Aleh Albelwi [4] developed a new technique by using deep learning to improve the performance of face recognition technique. Narayanan T [5] developed an algorithm with the help of principal component analysis and feed forward neural network to increase the recognition accuracy. Saranya R [6] proposed a new technique for face recognition using geometrical shaped facial feature. Narmatha Singh [7] developed a new technique called template matching algorithm for feature extraction. D. Wang [8] proposed a new model which was detected a human faces from images and assigned human matching names. Weitao Li [9] developed a

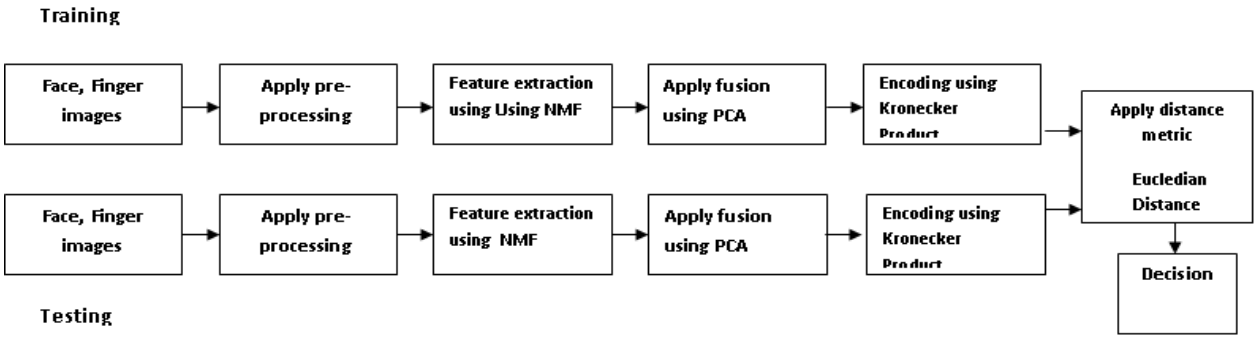

Figure 1: Mathematical model of proposed method

new methodology by using Gabor Wavelet transformation Algorithm for feature extraction. Hala[10] developed an algorithm using principal component analysis for appearance based feature extraction.

III. NON NEGATIVE MATRIX FACTORIZATION

Non negative Matrix factorization is mostly useful tool for analyzing the high dimensional data from that it extracts the sparse and meaningful features from data vectors. NMF calculate the matrix A approximately with low rank as A≈MH. Where A can be set up with n data point each with p dimensions such that $A \epsilon R^{pxn}$. Here the original p dimension can be reduced to r. ie $M \epsilon R^{pxr}$ and $H \epsilon R^{rxn.}$.

By using the Frobenius norm we can measure the MH

$$\|A - MH\|_F^2 = \sum_{i,j} (A - MH)_{i,j}^2$$

IV. RESULTS AND DISCUSSION

All the test results can be done on key sizes 8x8,16x16,...,64x64 for the training and testing. All these experiments can be done on 2GB RAM Intel core i3 processor with 500 GB HD.

In this method pre processing can be applied for the training images in the first stage. Next features can be extracted using Nonnegative Matrix Factorization (NMF). After getting the features, apply the fusing by using the Principle Component Analysis (PCA). Once fusion can be done these features can be encoded using kronecker product and stored these results in memory. Similarly take the testing images and apply the pre-processing and features can be extracted using Nonnegative Matrix Factorization. After getting the features apply the fusing by using the Principle Component Analysis (PCA). Once fusion can be done these features can be encoded

using kronecker product and obtained the results. Now these testing results can be compared with the training results by using Euclidean distance as a distance metric. Now threshold can be set and compare resultant value of Euclidean distance with this threshold. Based on that take decision whether that testing image is known image or unknown image. The above figure 1 shows the mathematical model of proposed method.

If we want to check the performance of the system we need to check the false matching rate and false non matching rate. In the false matching rate the system will treat the correct input as wrong input. In the false non mating the system will treat incorrect as a correct. Based on these two things we can check the performance of any bio metric system. Both these errors can be calculated based on the percentages of matching with the threshold value d. The following table 1will shows the results obtained by changing the key values.

Table 1: Performance Analysis

S.No	Key Size	Euclidean Distance	
		Similar	Dissimilar
1	8x8	0.33978	0.271168
2	16x16	0.367024	0.12945
3	24x24	0.292946	0.176628
4	32x32	0.2651	0.182478
5	40x40	0.286938	0.158918
6	48x48	0.209	0.192408
7	56x56	0.235434	0.177762
8	64x64	0.242026	0.151006

Here we consider the threshold value d=0.192. Based on this threshold value false match and false non match can be calculated. For this threshold value all the similar images can be identified but for the key size 8x8 false matching rate can be identified. Because very less features are having for the key size 8x8 false matching can be detected. The following figure 2 shows the results.

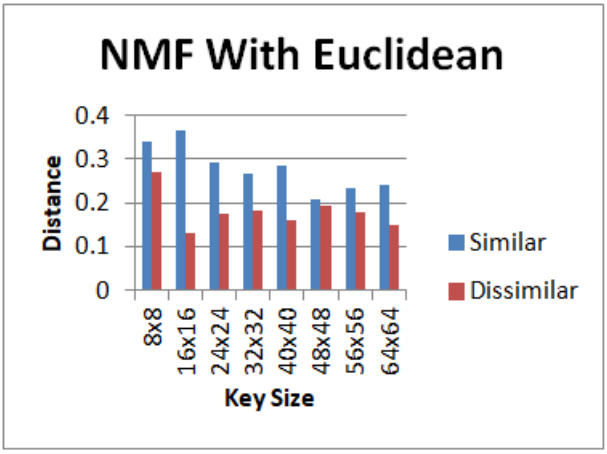

Figure 2. : Results graph using NMF factorization

V. CONCLUSION

For Identification and authentication feature extraction is a very important. There are various algorithms available in the literature for feature extraction. In this paper Non negative Matrix Factorization can be used for feature extraction . Once features can be extracted those features can be decoded with kronecker product and stored in a smart card. On the Testing Image also features can be extracted and compared these features with stored features in the smart card. Based on threshold get a conclusion whether that testing image is authorized or not.

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