Image Feature Encoding Using Lownerization Tensor

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Abstract

Nowadays, Technology is improving day by day. These days, vulnerability is the most important factor for any real-time application. There is a need to decrease the vulnerability of any application that is up to date. For many applications, till now we are using finger prints and faces as security. This paper advocates multimodal authentication using face and finger print. The image analysis process is divided into three parts. Preprocessing of images, Extracting the features from the image and Classification and interpretation of features. To save these extracting features, we need a technique so that these features cannot be vulnerable to anyone else. In this paper, Preprocessing can be done using Mean Square Error and Features can be extracted using Non-negative Matrix factorization. The proposed tensor technique called the Lownerization Tensor for encoding these extracted features.

Keywords: - Multimodal Authentication, Preprocessing, Tensors, Lownerization Tensor

1. Introduction

Nowadays, everyone and everywhere have access to the internet. Data collection has become a simple task. As a result, data base maintenance is fairly prevalent everywhere. When all of these databases are combined, the number of dimensions and database size will both grow.The first fundamental stage in any recognition method is feature selection and approximation. When the dimensions are large, feature extraction is challenging and computing complexity is significant. Approximation approaches [1-5] are particularly useful for picking the best features and extracting them. After extracting the features we have to store these features for authentication purpose. This authentication will act as a security for any application.

The security of any personal information or data is paramount. Biometric [6] is an authentication method that has mostly supplanted passwords and pin codes in recent years. Face, Finger print, and Palm are only a few of the qualities that are employed for authentication. Unimodal biometric systems were built for recognition and authentication in the past. Recognition is not done perfectly if the trait that is utilized for authentication is damaged.In Unimodal biometric system have to contend with a problems such as noisy data, intra-class variations, restricted degrees of freedom, spoof attacks and unacceptable error attacks. To overcome these problems by usingMultimodal authentication [7,8] can be utilized for recognition and authentication that is integrate the evidence by multiple sources of information.The concept of multimodal biometrics is gaining traction as a way to create authentication systems that are trustworthy, accurate, and robust. Sensor level, feature level, match-score level, rank level, and decision level information fusion can all be done in multimodal biometrics fusion [9].

In this paper, a new image encoding technique was proposed called the Lownerization tensortechnique, so that extracted image features can be stored securely for authorization of the image. This paper can be organized as follows in further sections. Section 2 provides Literature survey. The proposed technique is described in Section 3. Section 4 represents the experimental results and comparisons are demonstrated. The paper was concluded in Section 5.

2. Literature Survey

Feature encoding is an important element of the image rendering pipeline. These days, the codebook approach is used for image representation and is represented by codebook-based coding of the extracted local descriptors. However, codebook memory costs increase rapidly depending on the dimension of local functionality. Shinomiya et al. [10] introduced a compact codebook-based functional coding technique by using fuzzy clustering in two approaches. The first idea is to modify fuzzy clustering to properly compute high dimensional vectors such as local features. The second approach is to update the codebook for each image and use KL divergence to embed the differences in the image functionality.

Xihui Lin et al. [11] presented the optimization and expansion of Non-negative Matrix Factorization (NMF), which is utilized to solve non-negative matrix issues. To use a masking strategy on the NMF decomposition during iterating algorithms in order to keep particular structures or patterns in one or both of the output matrices, which can be created based on prior information and desirable attributes to generate a more meaningful decomposition.

Muja Marius et al. [12] developed scalable Nearest Neighbor Algorithms for High Dimensional Data to solve the difficulty of finding nearest neighbor matches to high dimensional vectors that represent the training data in computer vision machine learning algorithms. The proposed approach and the kd-tree are the most efficient algorithms for matching high-dimensional features. By scanning various hierarchical clustering trees, the suggested approach for matching binary features. The optimal nearest neighbor method and its parameters are determined by the properties of the data set, and they explain an automated setup procedure for determining the best algorithm for searching a certain data set. It is not possible to scale to enormous data sets in a single machine's memory. Any of the algorithms can be utilized with a distributed nearest neighbor matching framework that was proposed.

Lionel Moisan et al. [14] proposed a probabilistic criterion for evaluating the meaningfulness of a rigid set as a function of both the number of pairings of points (n) and the correctness of the matches. The projection of n physical points onto two viewpoints (stereovision) is generally limited to $n \geq 8$. In order to compensate for the restricted accuracy of the matches, more than 8 point matches are desirable when there is a rigid motion between two images.This method produces an objective to compare and assert that precise matches of a few points and approximate matches of a large number of points are equivalent, and it ensures that the expected number of meaningful rigid sets found by chance in a random distribution of points is as minimal as required. It also produces absolute rigidity detection accuracy requirements in the case of non-matched points, as well as optimal values of n, depending on the predicted match accuracy and outliner proportion. When the set of points matches up to 90% of outliners, an efficient random sampling approach was created to detect a rigid motion and estimate the basic matrix.

3D laser scanning is a novel technique for quickly creating a 3D picture representation of an object by collecting spatial position of points and obtaining 3D coordinates of the target surface. In the fields of photogrammetry and computer vision, obtaining a D model from objects is a difficult task.Xing changetal. [15] Proposed 3D modeling of spatial objects performed using spatial data acquired via a 3D laser scanner on the ground, and how to reconstruct a 3D scene model using laser range images. .. This approach described a collection of algorithms for 3D reconstruction, that is, the implementation of image segmentation and area registration based on planar features. After retrieving the image area, the image was segmented to extract the features of the plane and registered to recognize the initial configuration between the sensor's coordinate systems from the two views. Finally, create a triangular mesh to create a 3D surface model. The results of this method are accurate and robust.

3. Proposed Lownerization Tensor Technique.

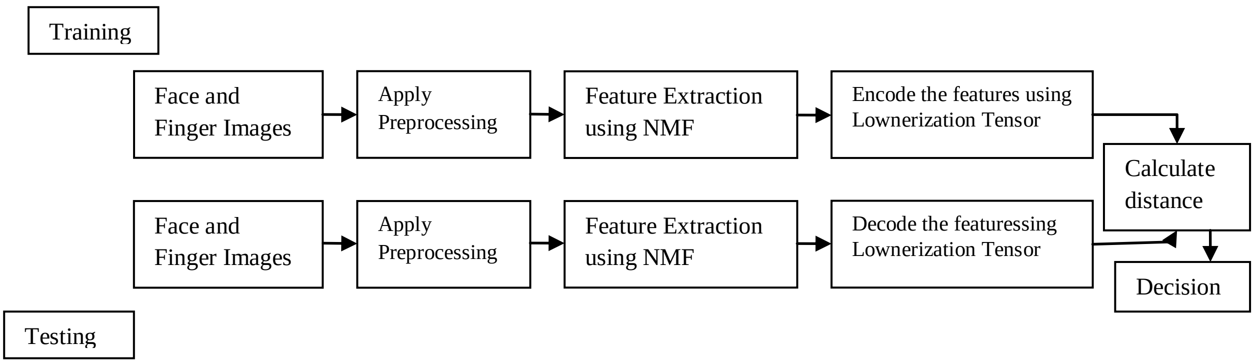

Figure 1: Block diagram of proposed Lownerization Tensor Technique.

3.1Preprocessing and Feature Extraction

Preprocessing involves removing unnecessary elements and enhancing contrast to make them more visible. Filtering can be divided into two categories. In image processing, there are two types: linear and nonlinear. Image processing is used in a variety of fields, including remote sensing, medical imaging, textiles, and material research. In this paper Image preprocessing done with the mean (average) or median filter is one of the strategies. The mean filter replaces each pixel's value with the average of all pixel values in a small area (often a N by N window, where N = 3, 5, 7, and so on). Each pixel's value is replaced with the median value obtained in a local neighborhood in the median filter.

Once preprocessing is over, the next step is feature extraction.The extraction of characteristics is critical for this identification.NMF divides a matrix A into two matrices with lesser ranks and non-negative entries[16].

$$X \approx AB \; where \; X \in R^{n\times m} \;\; A \in R^{n\times k} \; B \in R^{k\times m} \qquad (1)$$

Here the matrix X rows represents the features, matrix X columns represents the samples. A can be perceived as a feature mapping depending on the context. Samples are compactly represented in Column H. NMF can be expressed mathematically as

$$\min_{A\geq 0, B\geq 0} L(X, AB) + J_A(A) + J_B(B) \qquad (2)$$

The loss function can be defined as L(a,b) which is frequently selected as square error $\frac{1}{2}(a-b)^2$ or KL divergence distance as $alog\left(\frac{a}{b}\right) - a + b$

3.2 Feature Encoding using Lownerization Tensor method

Once features are extracted, they are stored in a smart card for authentication purposes. In the literature, there are many algorithms proposed by different types of authors. If these features are stored directly in the smart card, there is a chance for vulnerability. Hence, these features are encoded and stored in the smartcard, and at the time of verification, these features are decoded and used for authentication. In this paper, a new tensor method called Lownerization [17] is used for encoding and decoding. When computing the inner product, norm, and MTKRPROD[13,14,15], the multi-linear structure can be used instead of constructing the entire tensor. This is the main advantage of the Lownerization matrix.

Let $A \in C^N$ be a vector and it have the evaluation points $p \in C^N$. Let's divide [1, 2,...,N] into two vectors $m \in C^P \; and \; n \in C^Q \; with \; N = P + Q.$ Let us consider an interleaved partitioning (m=[1,3,..]and n=[2,4,…]) or black partitioning (m=[1,2,…P] and n= [P+1,…N]) can be used. Now the Lowner matrix $Z \in C^{P\times Q}$is defined as follows

$$(\boldsymbol{Z})_{\boldsymbol{p},\boldsymbol{q}} = \frac{\boldsymbol{f}_{\boldsymbol{m}(\boldsymbol{p})} - \boldsymbol{f}_{\boldsymbol{n}(\boldsymbol{q})}}{\boldsymbol{v}_{\boldsymbol{m}(\boldsymbol{p})} - \boldsymbol{v}_{\boldsymbol{n}(\boldsymbol{q})}}, \forall \boldsymbol{p} \in \{1,2,..P\}, \forall \boldsymbol{q} \in \{1,2,..Q\} \qquad (3)$$

3.3Distance Metric: These distance metrics are used to calculate the similarity between data points of training and testing.In this paper Mean Square Error(MSE) distance is used to calculate the distance between training and testing images. Let M and N are two images and each image contains K pixels and m_j and n_j represents the j^{th} pixel in image M and N then the MSE of two images M and N can be defined as

$$\text{MSE(M,N)} = \frac{1}{K}\sum_{i=1}^{k}(m_i - n_i)^2 \qquad (4)$$

4. Results and Discussion

In this paper as a first step in the training, image preprocessing can be applied to the face and finger by using the mean filter technique. After that, features can be extracted using Non negative matrix factorization. Once features can be extracted, they can be encoded with the Lownerization Tensor technique. Now these features can be stored in a smart card. In the authentication process, for the testing images first we need to perform the de-Lownerization technique and then follow the same steps in the order as mentioned above. At the end, calculate the difference between training and testing images with the help of the distance metric using Mean Square Error. Now define the threshold value based on the error obtained by running different types of testing and training images. Finally, compare the obtained distance with the threshold value and make a decision whether the person is authorized or not.

The results of experiments can be obtained using conventional databases [18, 19, 20]. All of these tests may be carried out in a Windows 10 environment with 6GB of RAM, an i3 Intel processor, and a 500GB hard disc.

The Non-negative Matrix factorization was used by for feature extraction, the Kronecker product can be used for feature encoding, and Euclidean distance metric was used for calculating the distance between training and testing with different key sizes from 8x8 to 64x64. Here the algorithm gives better results for 24*24 to 64*64 key sizes only and for 8x8 and 16x16 it would not work better.

The following Tables show the results of two methods. Results of existing method [16]. Table 1 shows the numerical results which is obtained by Feature Extraction using NMF, Kroneker product used as Encoding technique and Euclidean distance as a distance metric.The corresponding figure show in figure (2) for this model threshold T can be defined as 0.192.

Table 1: Existing method of Feature Extraction using NMF

S.No	Key Size	Euclidean (MSE)	
		Simiar	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

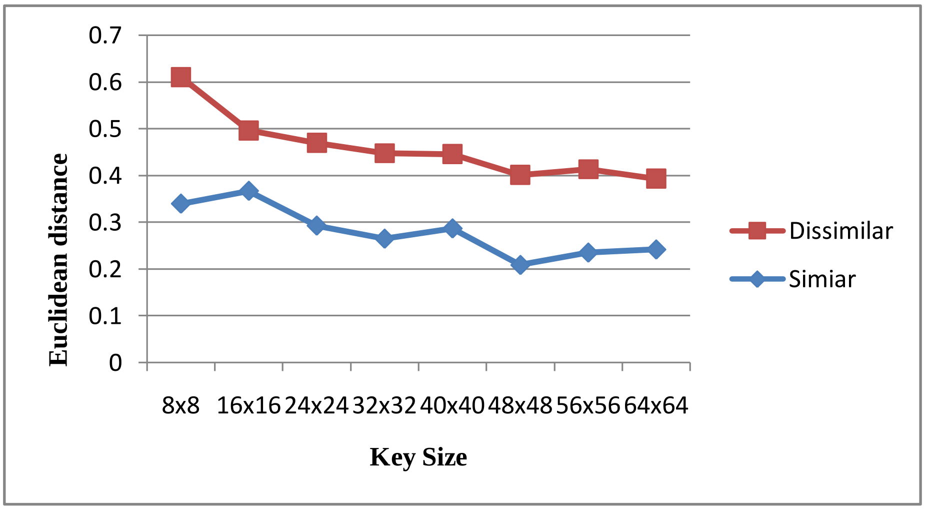

Figure 2: Exiting method of Feature Extraction using NMF, Kronecker product used as Encoding technique and Euclidean distance as a distance metric

The proposed method shown by Table 2 and figure 3 is obtained by Feature Extraction using NMF, Lownerization tensor used as Encoding technique and Mean Square distance as a distance metric. For this model threshold T can be defined as 6.40.

Table 2: Proposed Feature Extraction using NMF, Lownerization tensor used as Encoding technique and Mean Square distance as a distance metric

S.No	**Key Size**	**MSE**	
		Simiar	**Dissimilar**
1	8x8	4.350015	4.607736
2	16x16	6.402805	4.328069
3	24x24	11.648962	4.18441
4	32x32	21.367552	5.527439
5	40x40	20.331642	5.633834
6	48x48	73.444776	4.098385
7	56x56	32.247267	4.046477
8	64x64	43.27675	5.306438

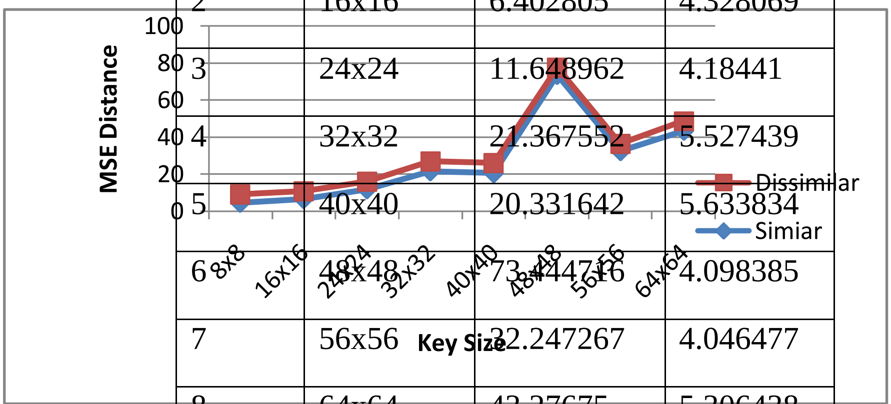

Figure 3: ProposedFeature Extraction using NMF, Lownerization tensor used as Encoding technique and Mean Square distance as a distance metric

When comparing these two different methods, method 1 does not work for the key sizes of 8x8 and 16x16. Whereas in method 2does not work for only the key size of 8x8.

5. Conclusion

In this paper, mean square error is used for preprocessing, and Nonnegative Matrix factorization is used to extract features. Finally, the Lownerization tensor approach can be used to encode features. The distance between the training and testing images can be calculated using the Mean Square Error. The findings were achieved using various key sizes ranging from 8x8 to 64x64. Compare the results to existing method, the proposed Lownerization technique works for the key size 16x16.

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