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SCRAMBLED DOMAIN FACE RECOGNITION VIA MANY KERNELS

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Abstract - *Expressions of face are an important factor in the modern human interacting systems that find the difference between the human expressive states at different times. Scrambling or encryption of data in a captured image gives a solution to an enhanced system. Consider the Internet of Things (IoT) directed distribution of image/video, the encryption of face is considered as a major part for protection of privacy. For this, biometric verification is required to get the encrypted data. After the encryption procedure the face models become chaotic signals. Using various face recognition methods, we can obtain the data, which is a traditional method. In this work a new approach called Many Kernel is used to handle the challenges of chaotic signal recognition in the scrambled domain. And incorporate a salience model into MK-RDA for pattern discovery from the chaotic facial signals.*

***Key Words*: scrambling, chaotic, kernel, salience, facial components.**

1. INTRODUCTION

Face recognition [1]-[4], has recently found a new use in web-based biometric verification, man-machine interaction, internet medical diagnosis, video conferencing, distance learning, visual surveillance, and psychological evaluation. In the context of mass internet technology, privacy has become an issue of wide concern in web-based video streaming. As a result, face scrambling [4] is emerging as a practical technique to protect privacy legally during video distribution over the public internet. By scrambling faces detected in private videos, the privacy of subjects can be respected. Compared with full encryption methods, face scrambling is a compromise choice because it does not really hide information; since unscrambling is usually achievable by simple manual tries even though do not know all the parameters. It avoids exposing individual biometric faces without really hiding anything from surveillance video. As shown in [3], scrambling has recently become popular in the research field of visual surveillance, where privacy protection is needed as well as public security. Another advantage of face scrambling over encryption is its computing efficiency, and usually it is far simpler than complicated encryption algorithms. In many business cases such as public surveillance, the purpose is limited to only privacy protection from unintentional browsing of user data. Hence, full encryption becomes unnecessary in this context.

By comparing different encryption techniques, face scrambling is used to encipher or hiding the image, not data. By using manual tries it can be easily unscrambled. Face scrambling is simpler than many encryption algorithms and is computationally feasible. Face scrambling can be performed in many ways. Some scrambling technique like masking and cartooning will misplace the facial data. One of the basic step called Arnold transform is use to recover the data from encrypted information.

1.1 Arnold Scrambling

Face scrambling is emerging as a practical technique to protect privacy legally during video distribution over the public internet. Usually scrambling can be done simply by masking or cartooning. However, this kind of scrambling will simply lose the facial information, and hence subsequent face recognition or verification becomes unsuccessful in this case. Especially for security reasons, it is obviously not a good choice to really erase human faces from surveillance videos. The existing system has some following drawbacks. They are encryption algorithms are more complicated, wastage of the time and cost, in the case of encryption changes of semantic components are unrecoverable. Face recognition and verification becomes unsuccessful and it is a complex method.

The Arnold transforms, as a basic step in many encryption algorithms, is a kind of recoverable scrambling method. Scrambled faces can be unscrambled by several manual tries. After Arnold transformation of the image, pixel's location of the image in space is completely changed, but it does not change the value of image pixel, so the image histogram is the same. Except some very special images, most of image is difficult to obtain important clues from image histogram. Though this does not pose too much security issues on image, to further enhance the security of encrypted image, we first use Arnold transformation to get scrambling image[1], then use the chaotic array to change grey value of each pixel of the replaced image, so as to obtain the final encrypted image. So in this work, Arnold transform based scrambling method is used. And a new approach called Many Kernel is used to handle the challenges of chaotic signal recognition in the scrambled domain. And incorporate a salience model into MK-RDA for pattern discovery from the chaotic facial signals. So it has the following advantages. They have high computing efficiency and it is simpler than the encryption algorithms, it is simpler and recoverable and efficiently classify and recognizing the face images from scrambled domain.

2. PROPOSED SYSTEM

In this work, develops a new approach called Many Kernel to handle the challenges of chaotic signal recognition in the scrambled domain. And incorporate a salience model into the MK-RDA for pattern discovery from chaotic facial signals.

Here image processing techniques are also used. It consists of 5 modules. The work Scrambled Domain Face Recognition via Many Kernels consists of the following modules. They are:

1. Face Scrambling
2. Semantic Salience Mapping
3. Dimensionality Reduction
4. Face Classification and Recognition

2.1 Face Scrambling

In many IoT applications, it is not encouraged to hide any information by encryption; on the other hand, it is legally required to protect privacy during distribution and browsing. As a result, scrambling becomes a compromise choice because it doesn't really hide information (unscrambling is usually achievable by simple manual attempts), but it does avoid exposing individual faces during transmission over the internet. Additionally, scrambling usually has much lower computation cost than encryption, making it suitable for simple network-targeted applications using low power sensors. Among various image scrambling methods, the Arnold scrambling algorithm has the feature of simplicity and periodicity. The Arnold transform, was proposed by V. I. Arnold in the research of ergodic theory; it is also called cat-mapping before it is applied to digital images. It has been widely used in visual surveillance systems where it is favoured as a simple and efficient scrambling method which nevertheless retains some spatial coherence. In this project, Arnold transform based scrambling method is used to set up the test environment. In the Arnold transform, a pixel at point (x, y) is shifted to another point (x', y') by:

$$\begin{bmatrix} x' \\ y' \end{bmatrix} = \begin{bmatrix} 1 & 1 \\ 1 & 2 \end{bmatrix} \begin{bmatrix} x \\ y \end{bmatrix} \bmod N,$$

which is called two-dimensional Arnold scrambling. Here, x and y are the coordinates of the original pixel; N is the height or width of the square image processed; x' and y' are the coordinates of the scrambled pixel.

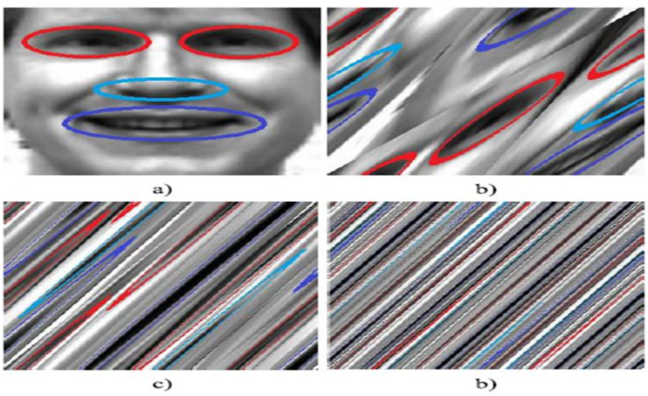

Fig 1: Face scrambling by the Arnold transforms. (a) Facial components. (b) After one Arnold transforms. (c) After 2 Arnold transforms. (d) After 3 Arnold transforms.

By the replacement of the discrete lattice for transplantation, the Arnold transform produces a new image after all pixels of the original image have been traversed. In addition, Arnold scrambling also has the property of being cyclic and reversible. Fig 1 (a) shows a face with its facial components (i.e., eyes, nose and mouth) circled by different colours. Fig 1 (b) shows the scrambled face after one operation of the Arnold transform, where it can be seen that facial components have drastic displacements. Fig 1(c) and (d) shows the scrambled faces after two and three operations of the Arnold transform. In comparison with Fig 1 (b), the scrambled faces in Fig 1(c) and (d) are more difficult to identify by the human eye. In this work, use three operations of the Arnold transform to scramble all faces. It can see from Fig 1, before scrambling, facial components can easily be identified by the human eye. After scrambling, the images become chaotic signals, and it is hard to figure out eyes and noses. Since semantic facial components are considered important clues for face recognition, then need to find a way to incorporate semantic approaches into the scrambled domain to attain higher matching accuracy. In many IoT based applications, it may not be allowed to unscramble detected faces due to privacy-protection policies. Moreover, unscrambling may involve parameters (such as the initial shift coordinates) that are usually unknown by the online software. Facial recognition in the scrambled domain then becomes a necessity in these IoT applications.

2.2 Semantic Salience Mapping

Since semantic components are important clues to identify a specific face, and need to find a way to introduce these factors in statistic face modelling. This project uses salience learning for semantic facial mapping, and incorporates the learned semantic map into a random forest method for face recognition.

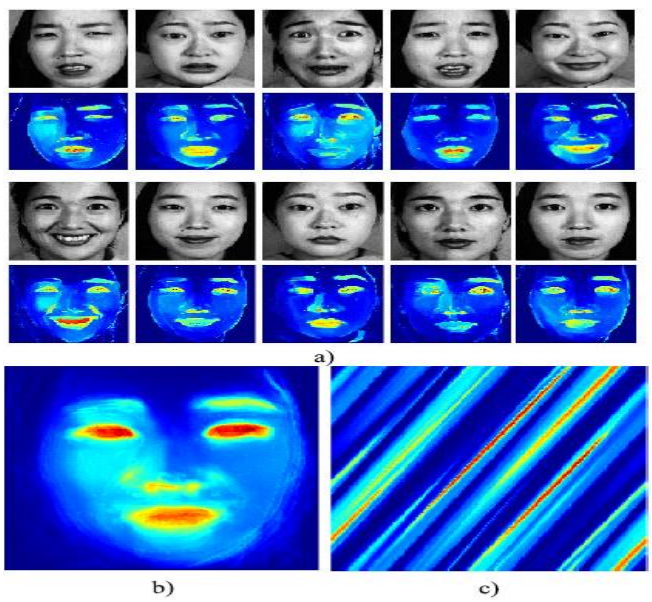

Fig 2: Semantic salience of facial images. (a) Structural salience mapping of semantic features. (b) Summarized semantic map. (c) Scrambled semantic map.

2.3 Face Classification and Recognition

Given a training dataset, faces are forwarded to the training procedure. The offline procedure then learns its semantic salience map. Following this, the database is scrambled and the feature space is reconstructed by multiplying salient features according to their semantic salience weights. Random sampling is then applied to select features sparsely to construct as many kernels as is allowed, and discriminant analysis is used to learn a kernel subspace for each kernel. After a scrambled facial image is input as a test. A Random Forest Method is used for classifying and recognizing the faces. It is a tree based method consists of many decision trees. Each tree gives a classification and the output is an aggregate of these classifications. First extract the features from face images, then uses the Random Forest algorithm to classify the images based on the extracted features.

3. IMPLEMENTATION AND EXPERIMENTAL RESULTS

The proposed system attempts to present a method, which is used for recognizing the face image from scrambled domain based on the following important steps:

- Scrambling
- Salience Mapping
- Reduction of Dimensions
- Classification and Face Recognition

3.1 Scrambling

The steps performed for face scrambling are as follows:

a) Read the input image, it is a face image. Then detecting the exact face from the image

b) By using Viola- Jones Face Detection Algorithm [8].

c) Cropping the faces from the input images and converts it in to gray scale.

d) Scrambling the face images by using Arnold transform.

3.2 Salience Mapping

A scrambled face has a very different appearance from its original facial image. While we can easily match a 3D model to a normal facial image, it becomes extremely hard to do so after the face has been scrambled. In the scrambled domain, semantic facial components simply become chaotic patterns. In this case construct the semantic map of each face image. The steps for constructing the semantic map are as follows:

a) Compute the Fast Fourier Transform of the image.

b) Apply Gaussian Mixture Model to this image.

c) Remove or filtered out the background objects and extract the foreground objects like eye, nose and mouth.

d) Compute the features like left eye, right eye, nose top, nose chin.

e) Compute attribute details are the eye to eye, eye to nose bridge, nose bridge to nose tip, nose tip to eyes, nose bridge to chin and length of face.

3.3 Reduction of Dimensions

a) Kernel Principal Component Analysis (KPCA) is used for dimensionality reduction.

b) Compute the Eigen values and Eigen vector of the feature set. It reduces the dimensions of the features.

3.4 Classification and Face Recognition

a) Random Forest method is used for face classification and recognition.

b) Construt the decision trees and extract the features.

c) Classify the face images based on the extracted features.

3.5 Results

The algorithm discussed above is implemented using MATLAB R2013a. The project consists of many modules and sub modules. The input image is a face image. The input image is scrambled by using Arnold transform. This is implemented in the first module. Then second module constructs the semantic salience map. Dimensionality reduction is performed in the third module. Final module implements the face classification and recognition. It provides high recognition accuracy.

These results prove that the proposed technique is used to improve the recognition accuracy. And incorporate a mechanism called salience model into many kernels for pattern discovery from chaotic facial signals; the semantic features are usually salient and useful for facial pattern classification. The experimental results successfully demonstrate that the proposed scheme can effectively handle the chaotic signals and significantly improve the recognition accuracy.

Fig 3: Input face image

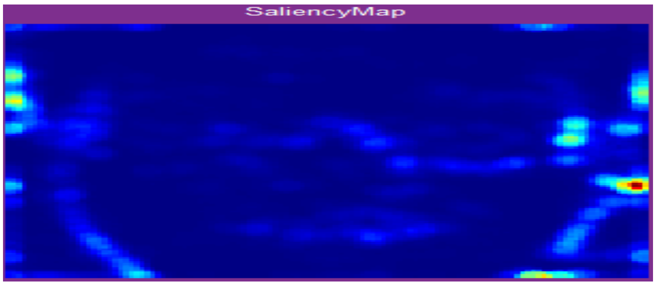

Fig 4: Saliency map

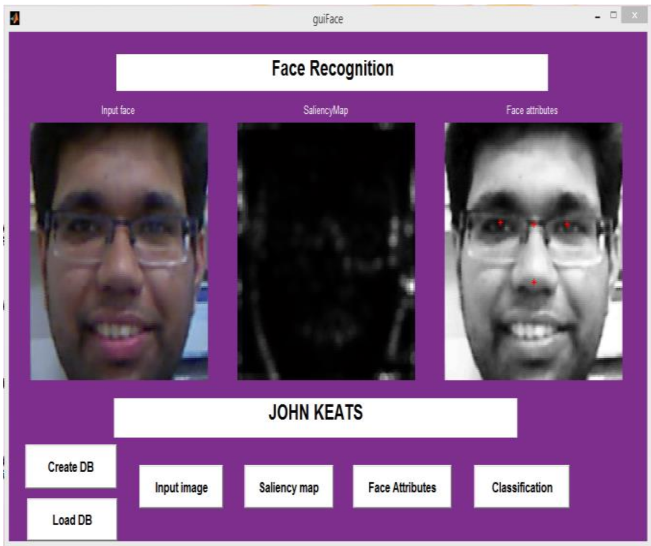

Fig 5: GUI of face recognition system

4. CONCLUSION

Identified a new challenge in scrambled face recognition originated from the need for biometric verification in emerging IoT applications, and developed a salience-aware face recognition scheme that can work with chaotic patterns in the scrambled domain. In this method, conjectured that scrambled facial recognition could generate a new problem in which "many manifolds" need to be discovered for discriminating these chaotic signals, and proposed a new ensemble approach – Many-Kernel for scrambled face recognition. And incorporated a salience-aware strategy to handle chaotic facial patterns in the scrambled domain, where random selection of features is biased towards semantic components via salience modelling. The experimental results successfully validated that the proposed scheme can effectively handle chaotic signals and drastically improve the recognition accuracy, making this method is a promising candidate for emerging IoT applications.

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