Lossy Image Compression For Multi Application Smart Card

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***Abstract*—A single multi application smart card can be used to replace the various cards people now carry for use in public transport, driving license, health insurance cards, national identity cards etc.,. Important challenges in the implementation and deployment of multi application smart cards are the protection of privacy of the card holder, security, Authentication and efficient storage of data. Smart cards can be used anywhere by medical emergency crew to quickly learn about previous ailments even if the affected person is incapable to interact with anybody. In this paper we investigate lossy compression algorithms on images typically used in multi application smart card including finger print images, facial images and medical images which have their own degree of importance in each of their individual applications.**

Keywords-Smart Card, Image Compression, Wavelet, Symlet

I. INTRODUCTION

The future of smart cards emphasizes not only to contain data in its memory but also perform operations like comparing data with an external database, computing a digital signature from some other data and most importantly include multiple applications. Privacy, Security, Authentication plays an important role in multi application smart cards and cards should have the capability to store and retrieve data in secure areas that cannot be accessed from outside the card, but only by the software on the card which makes them particularly good for security purposes such as protecting the confidentiality of encrypted files, or providing proof of a transaction. Where a requirement for identification includes an underlying requirement for authentication, smart cards are usually the best tool for the job [1].

A major drawback of smart cards is the limited and expensive storage medium built into the card. With the gaining popularity of secure online databases the problem of storage space can be mitigated by identifying the data we are seeking and to control access to that information by using pointers to a record in the database and also identify the category to which the user belongs and their rights to view or change the data. This is very important, for example, in a driving license the validity of the driving license along with history of offences may be needed by one group of people whereas revoking the license or recording offences may be handled by a different group of personnel belonging to different departments. Similarly in health records systems, different groups of health professionals have different needs and rights to view patient records which is crucial to protect the privacy of the patient.

France’s Carte Vitale card facilitate controlled access to medical records, which is stored centrally or in distributed environment and access to records requires both the patient’s card and a health professional’s card – the level of access granted depends on the qualifications and specialization of the professional;

Malaysian government multipurpose smartcard (called MyKad) is one of the first implementation of the national identity card (NIC) and driving license (DL) applications into the smart card. W.H.Loo et.al,[2] had done extensive research to study the user acceptance of MyKad applications with recommendations to increase the acceptance rate and to resolve the discovered issues.

Toji et al., proposed a network based platform for multi application smart card for multiple business entities over an open network[3]. Markantonakis et al., study whether smart card technology in the banking sector can be used, not only for combating fraud, but also in order to achieve a competitive advantage without suffering from traditional IT system drawbacks[4]. Authentication in multi application smart card has been proposed by integrating a handwritten signature and digital signature into an public key infrastructure [5].

In this paper we investigate lossy compression techniques using symlets on images required for various applications in a multi application smart card framework. In this work we propose to compress images including photo of the smart card holder, biometric information and medical images of the patient. The ultimate goal of medical image compression is to perform medical image matching from a online server containing high resolution images.

This paper is organized into the following sections. Section II discusses the symlet wavelet function, Section III describes the experimental setup with results and Section IV discusses and concludes this paper

II. SYMLETS WAVELETS

Wavelet is a waveform that is bounded in both frequency and time. Fourier analysis consists of breaking up a signal into sine waves of various frequencies. Similarly, wavelet analysis is the breaking up of a signal into shifted and scaled versions of the original (or *mother*) wavelet. The *continuous wavelet transform* (CWT) is defined as the sum over all time of the signal multiplied by scaled, shifted versions of the wavelet function ψ.

Mathematically the continuous wavelet is defined by

$$C(scale, position) = \int_{-\infty}^{\infty} f(t)\psi(scale, position, t)dt$$

The results of the CWT are many *wavelet coefficients* C, which are a function of scale and position. Multiplying each coefficient by the appropriately scaled and shifted wavelet yields the constituent wavelets of the original signal:

The symlets are nearly symmetrical wavelets proposed by Daubechies as modifications to the db family[6]. The properties of the two wavelet families are similar. Symlets are compactly supported wavelets with least asymmetry and highest number of vanishing moments for a given support width.

III. EXPERIMENTAL SETUP

In this work MRI image, passport photograph of card holder and fingerprint images obtained from FVC2006 competition were used to evaluate the symlet 2 compression algorithm with various decomposition levels. Threshold was computed using the Birge-Massart Strategy. Some of the images used are shown in figure 1.

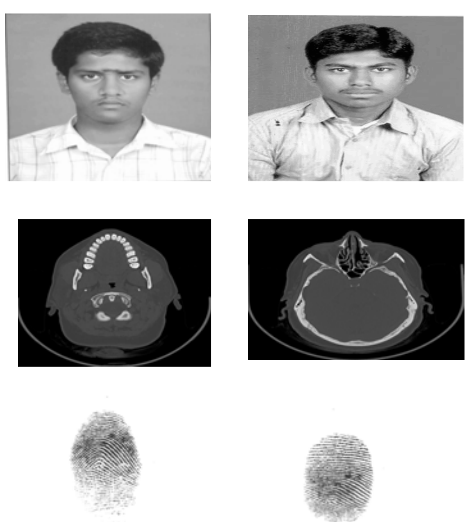

Figure 1. Different images used in the experimental setup

The output obtained using symlet 2 compression for various decomposition values for passport photos are tabulated in table 1.

Table 1: Compression ratio using symlet 2 with various decomposition levels for passport photos

Image	Decomposition Level	No. of Zeros	Retained Energy
Photo1	2	84.28%	100%
Photo2	2	84.13%	99.18%
Photo1	4	98.65%	99.93%
Photo2	4	98.5%	99.76%
Photo1	5	99.58%	99.8%
Photo2	5	99.51%	99.55%

Image quality starts degrading over decomposition level of 2 however at decomposition level of 4, the image is still closer to the original image and identifiable by visual inspection. The compressed image obtained is shown in figure 2.

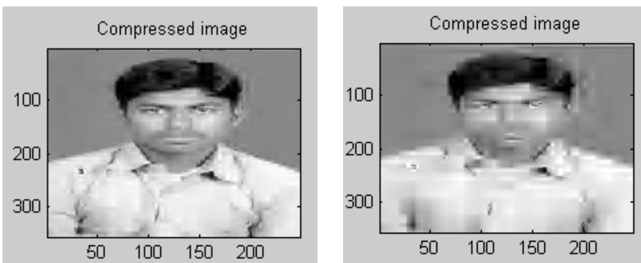

Figure 2 : Compressed image at decomposition level of 4 & 5.

The output obtained for medical images for different decomposition level using symlet 2 is tabulated in table 2.

Table 2: Compression ratio using symlet 2 with various decomposition levels for MRI images

Image	Decomposition Level	No. of Zeros	Retained Energy
MRI1	2	86.77%	99.87%
MRI2	2	86.67%	99.84%
MRI1	4	98.79%	97.84%
MRI2	4	98.79%	96.94%
MRI1	5	99.63%	94.45%
MRI2	5	99.63%	93.16%

At decomposition level 4 MRI images are still able to maintain all the features whereas image starts degrading at decomposition level 5 as shown in figure 3.

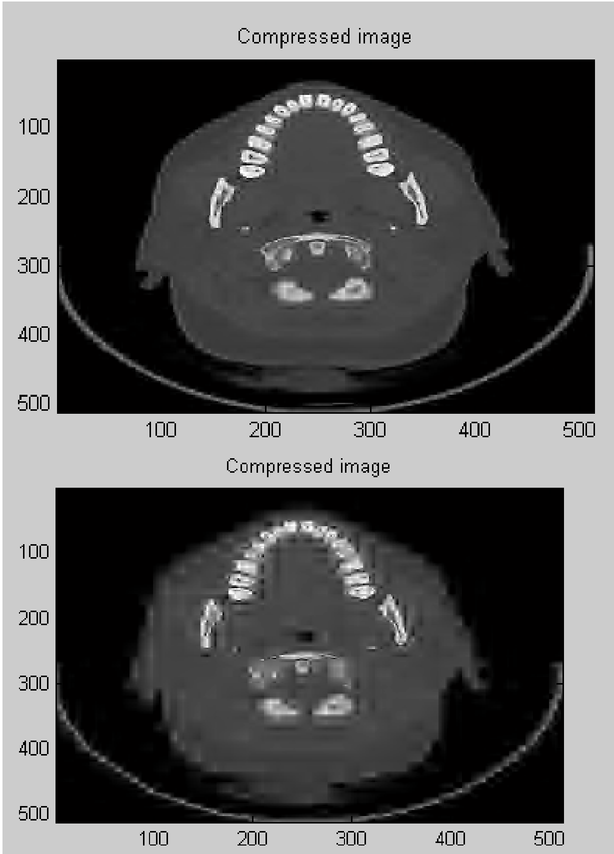

Figure 3 : MRI compressed image at decomposition level 4 and 5 respectively.

The compressed fingerprint images are tabulated in table 3 for different levels of decomposition.

Table 3: Compression parameters using symlet 2 with various decomposition levels for fingerprint images

Image	Decomposition Level	No. of Zeros	Retained Energy
Fingerprint1	2	86.5%	100%
Fingerprint2	2	86.06%	99.99%
Fingerprint1	4	98.74%	99.73%
Fingerprint2	4	98.69%	99.66%
Fingerprint1	5	99.61%	99.43%
Fingerprint2	5	99.61%	99.44%

Minutiae are clearly visible at decomposition level 4 which is crucial for any fingerprint verification engine. Finger print images can be stored in the smart card itself rather than transfer to some other storage medium during verification. This will enhance the security measure implemented using fingerprint. Compressed images at decomposition level 4 and 5 is shown in figure 4.

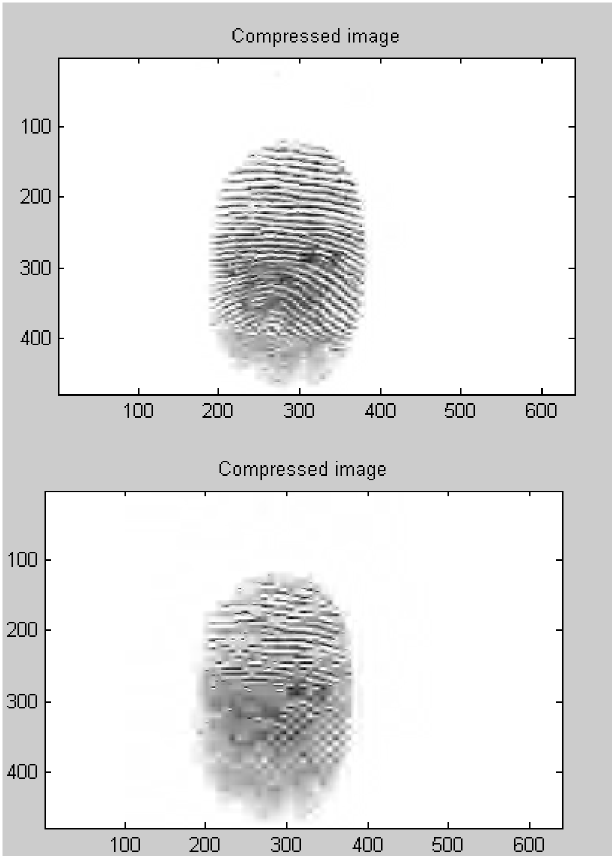

Figure 4 : Fingerprint compressed images at decomposition level 4 and 5 respectively.

IV. Conclusion

In this paper we used the symlet compression technique at various decomposition levels and studied the effect of compression on three types of images relevant to a multi purpose smart card. From the experimental setup it is found that photograph and fingerprint of the smart card holder can be stored in the smart card itself using compression techniques. Medical images in the smart card can be used for initial diagnosis during an emergency, however architecture need to be proposed to retrieve lossless medical images from a medical image archiving system.

It is also found that at decomposition level 2 the losses in the image are negligible and at level 4 the losses in the image are manageable for visual verification and fingerprint verification. However images degrade at decomposition level greater than 4.

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