Encryption, Watermarking and Mojette

Security & Mojette

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Outline

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- *Patrizio Campisi (Uni Roma 3)*
- *Simone Colosimo (Uni Roma 3-)*
- *Eric Grall (Thales-)*
- ...

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Publications (Security).

- C. Zhang, J. Dong, J. Li, F. Autrusseau, "A New Information Hiding Method for Image Watermarking Based on Mojette Transform", ISNNS, 2010
- A. Kingston, F. Autrusseau, E. Grall, T. Hamon, B. Parrein, "Mojette based security" (chap 10) The Mojette transform: Theory and Applications,wiley, 2009
- A. Kingston, S. Colosimo, P. Campisi, F. Autrusseau, "Lossless Image Compression and Selective Encryption Using a Discrete Radon Transform", IEEE-ICIP 2007
- F. Autrusseau, P. Evenou, T. Hamon, "Secure Distributed Storage based on the Mojette transform", Notere 2006
- F. Autrusseau, JP. Guédon, "Chiffrement Mojette d'images médicales", ISI, Lavoisier, 2003
- F. Autrusseau, JP. Guédon, Y. Bizais, "Watermarking and cryptographic schemes for medical imaging", SPIE Medical Imaging, 2003
- F. Autrusseau, JP. Guédon, "A joint multiple description-encryption image algorithm", ICIP 2003
- F. Autrusseau, JP. Guédon, "Perceptual image watermarking using a secure Mojette transmission scheme", COST 276, 2003
- F. Autrusseau, JP. Guédon, "Image Watermarking in the Fourier Domain Using the Mojette Transform", IEEE-DSP, 2002
- F. Autrusseau, JP. Guédon, "Image watermarking for copyright protection and data hiding via the Mojette transform", SPIE 2002
- F. Autrusseau, "Modélisation Psychovisuelle pour le tatouage des images", Signal and Image processing. Ph. D. Thesis, Université de Nantes, 2002. in French
- JP. Guédon, N. Normand, P. Verbert, B. Parrein, F. Autrusseau, "Load-balancing and scalable multimedia distribution using the Mojette transform", ITCOM, 2001

Outline

Funded Projects.

Research Projects

- ANR-ARA/SSIA - “Transfert Sécurisé d’images d’art Haute Résolution” (TSAR) - (2005-2008)
- Funding from Région Pays de la Loire, postdoctoral position (Andrew Kingston) (2007-2008)
- OSEO/Région Project - Miles (2006-2009)

Partners

- IRCCyN, IETR, LIRMM, GIPSA-Lab, C2RMF, LINA, IREENA, LERIA, LUIM, LISA, IMN-PCM, LGMPA, LAUM, LSO, UCO2M.

Outline

Topics.

Mojette-based security

- Watermarking
- Encryption
- Shared secret

Encryption

- Encryption+watermarking
- Encryption+coding

Watermarking - goals.

Protection de copyright

- Embed an invisible copyright within images
- Robustness against attacks

Steganography

- Transmit secret data
- Invisible and statistically not detectable

Fingerprinting

- Embed a fragile watermark
- Check Authenticity
- *Traitor tracing*

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Mojette-based watermarking.

Embed ghosts

- Embed Mojette ghosts onto the image's LSB planes.
- Transmit Mojette projections for which the ghost is invisible.
- Transmit other projections as a detection key.

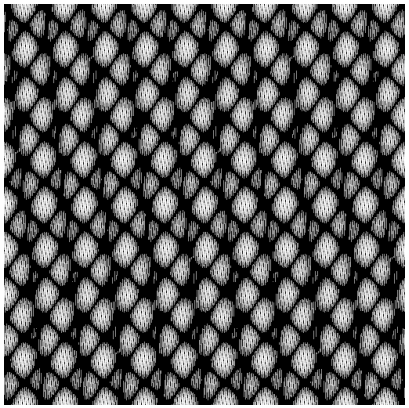
- F. Autrusseau, JP. Guedon, "Image watermarking for copyright protection and data hiding via the Mojette transform", SPIE Electronic Imaging, Security and Watermarking of Multimedia Contents IV, vol. 4675, pp. 378-386, San Jose, CA, January 2002.
- F. Autrusseau, JP. Guedon, "Image Watermarking in the Fourier Domain Using the Mojette Transform", 14th IEEE International Conference on Digital Signal Processing (DSP2002), vol. II, pp. 725-728, Santorini Greece, July 2002.

Mojette-based watermarking.

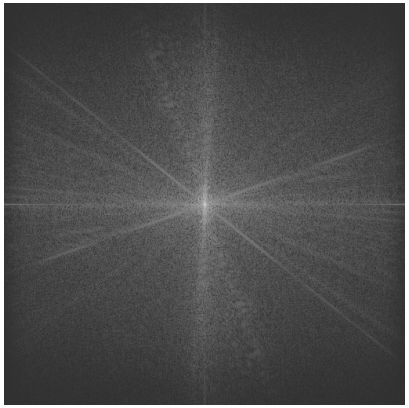
Embed a Mojette ghost within the Fourier spectrum.

(a) Original Image

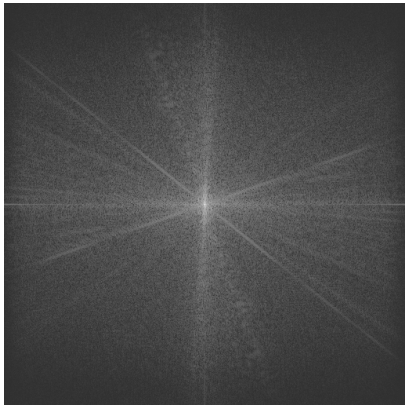
(b) Marked Image



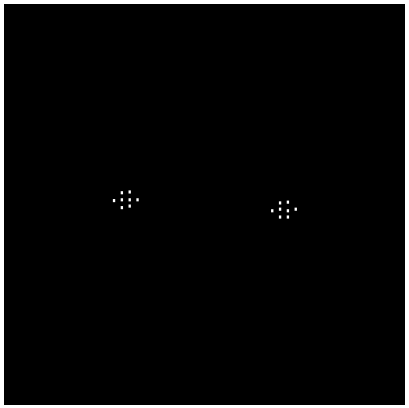
(c) Spatial watermark



(d) Original Spectrum



(e) Marked spectrum

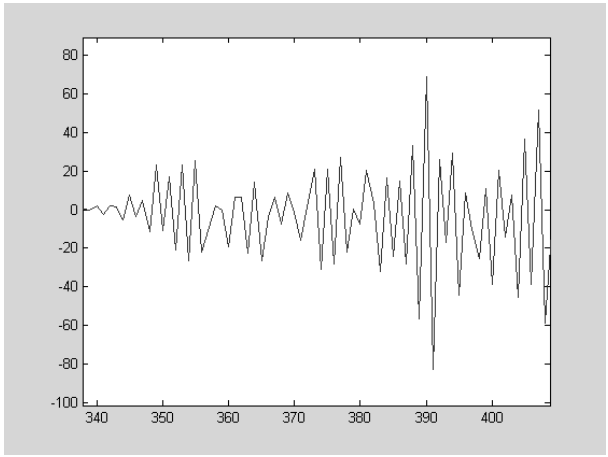


(f) Watermark in Fourier space

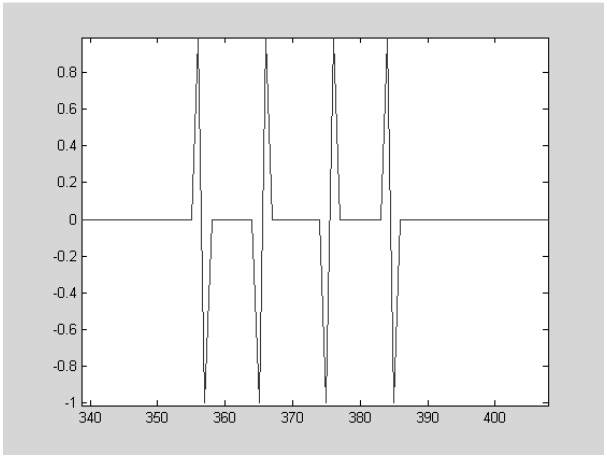
Figure : Watermarking

Mojette-based watermarking.

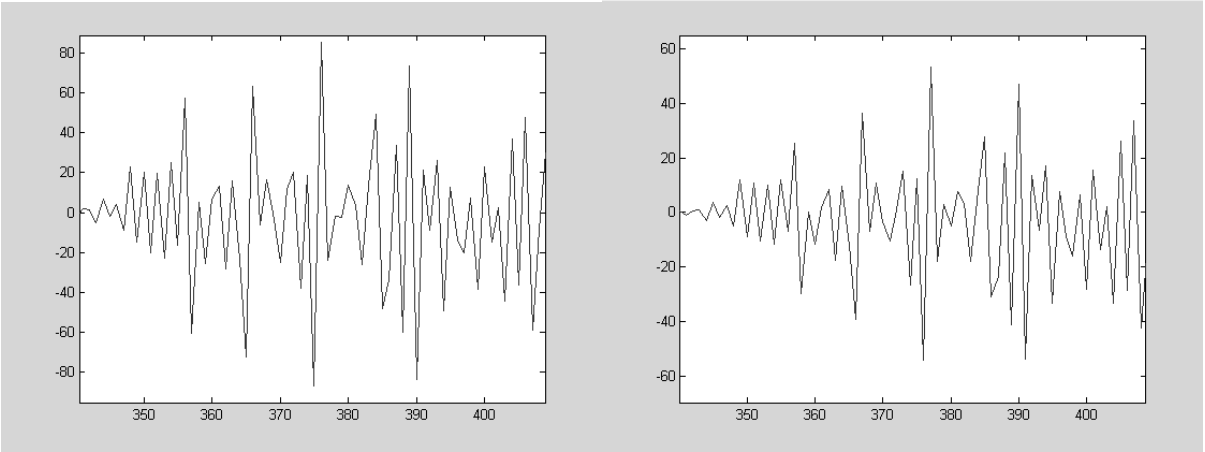
The Mojette transform is used for the detection...



(a) Proj. of the Original spectrum



(b) Proj. of the ghost



(c) Proj. of the marked spectrum (d) Proj. marked & attacked spectrum

Figure : Watermark Detection

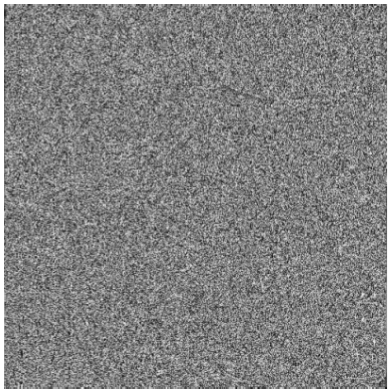
Outline

Mojette encryption.

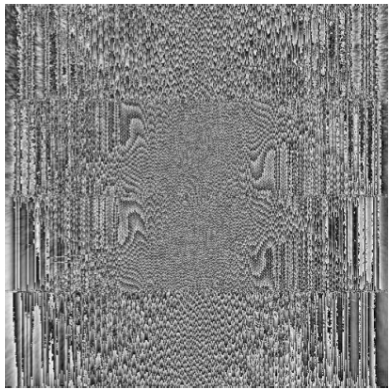
We can take benefit from the inverse Mojette instability... (erroneous projections backprojection)

(a) *One single modified bin.*

(b) *One single modified bin.*



(c) *Noise addition onto one proj.*



(d) *Noise addition onto one proj. (mod256).*

Mojette encryption.

Use a reconstruction path

- We keep track of the 1 to 1 (bin to pixel) correspondences during the direct MT.
- Store a unique path.
- Encrypt unused bins.
- $\rightarrow$ The original data is mixed with encrypted data

- F. Autrusseau, JP. Guedon, Y. Bizais, "Watermarking and cryptographic schemes for medical imaging", SPIE Medical Imaging, Image processing, vol. 5032-105, pp. 958-965, San Diego CA, USA, 15-20 February 2003.
- F. Autrusseau, JP. Guedon, "A joint multiple description-encryption image algorithm ", IEEE International Conference on Image Processing, ICIP'03, (3), pp. 269-272, Barcelona, Spain, 2003.

Mojette encryption.

Backprojection path.

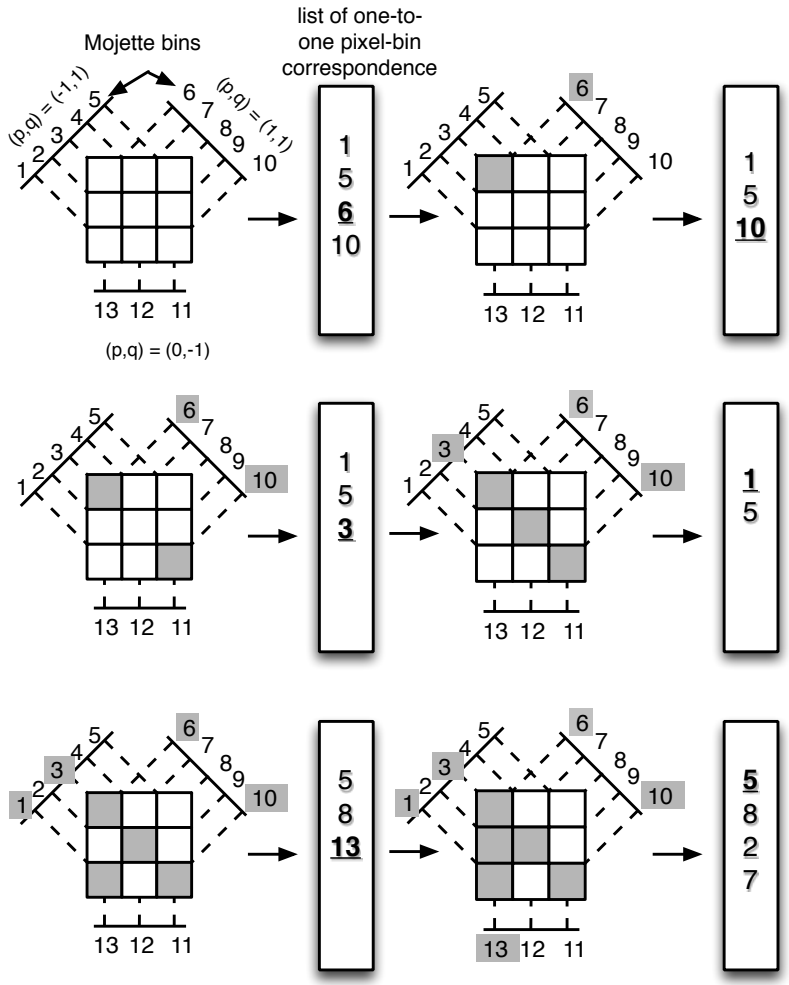


Figure : Encryption

Mojette encryption.

The number of possible paths significantly increases.

$$C_n^k = \frac{n!}{k! \times (n-k)!}$$

#bins	19	20	22	23	24	25	30	34
C_n^k	969	4845	74613	2.4^5	7.3^5	2.0^6	1.4^8	2.2^9
Directions	(1,5)	(1,1) (1,3)	(1,6)	(1,2) (1,3)	(1,0) (1,1) (1,3)	(1,7)	(1,1) (1,2) (1,3)	(1,0) (1,1) (1,2) (1,3)
Redundancy	0.187	0.250	0.375	0.437	0.500	0.562	0.875	1.125

For a 4×4 ! image

Outline

Encryption+Coding with the Mojette.

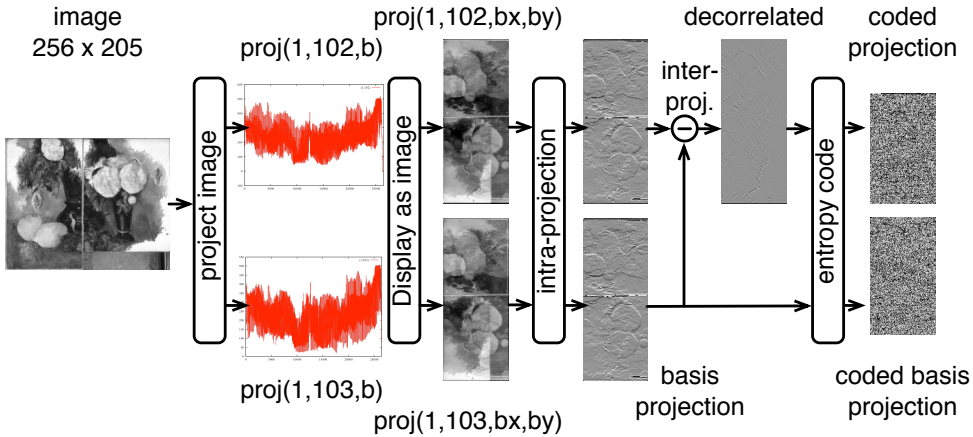
Encryption+Coding with the Mojette

- Inter-projections coding
- Intra-projections coding

Inter-projections coding

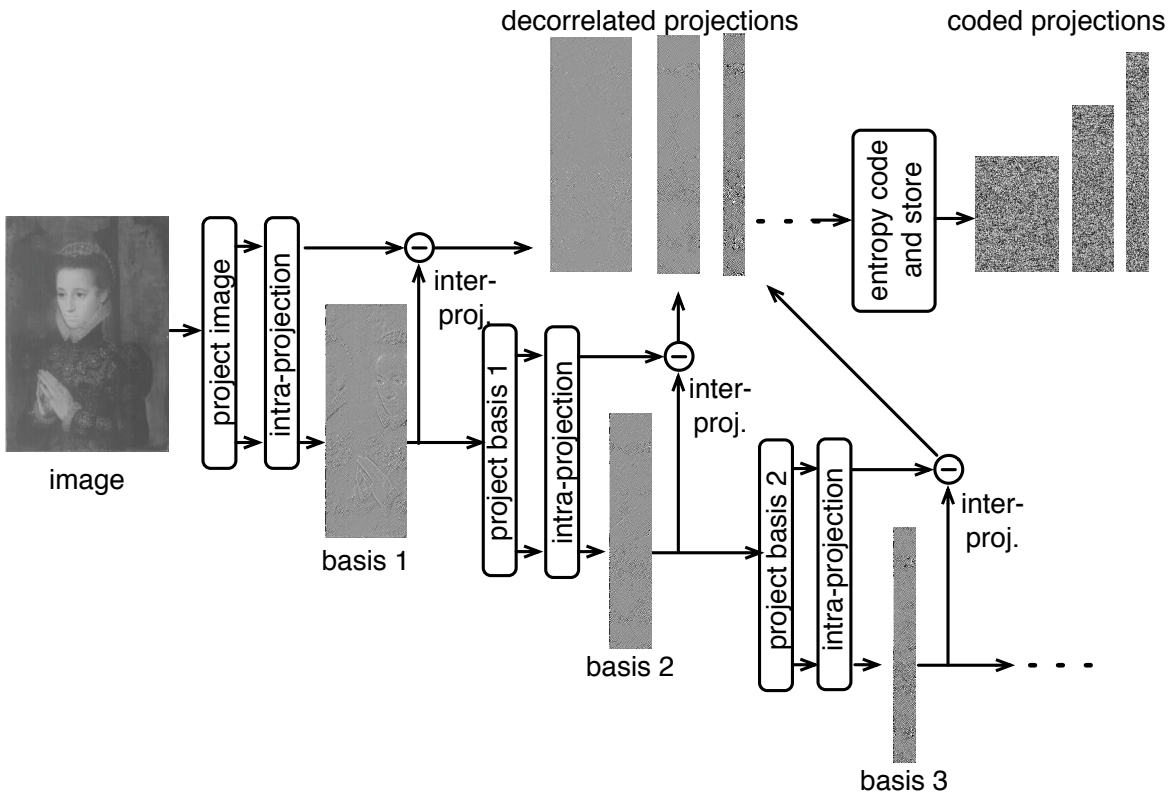
- Basis Projection +
- Uncorrelated data

Basis Projection / difference projection.



Encryption+Coding with the Mojette.

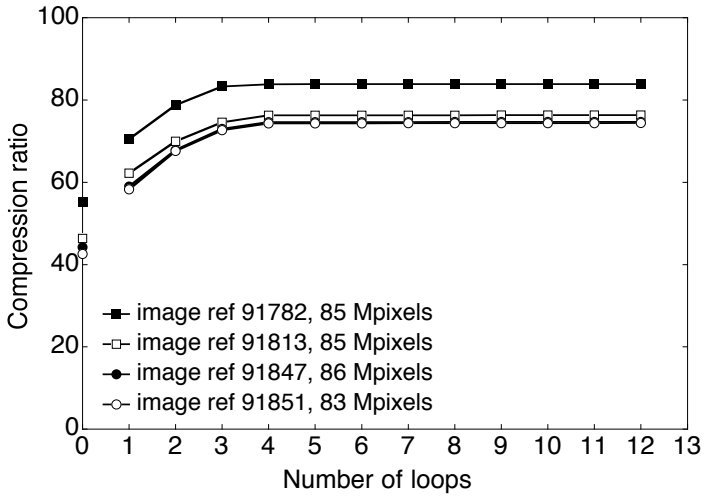
A cascade of projections.

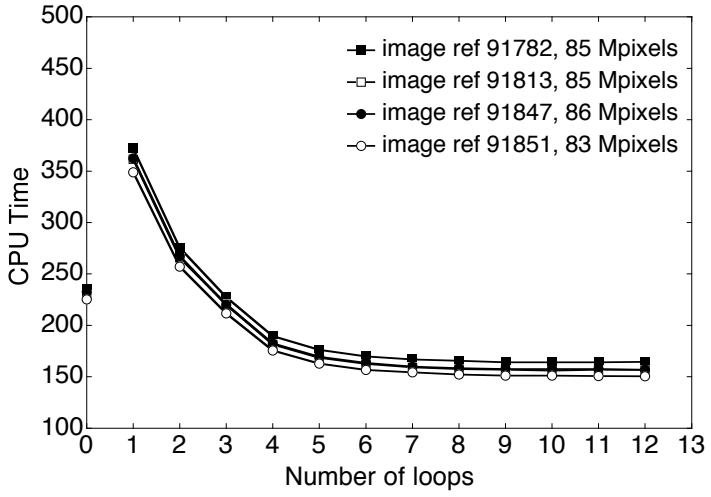


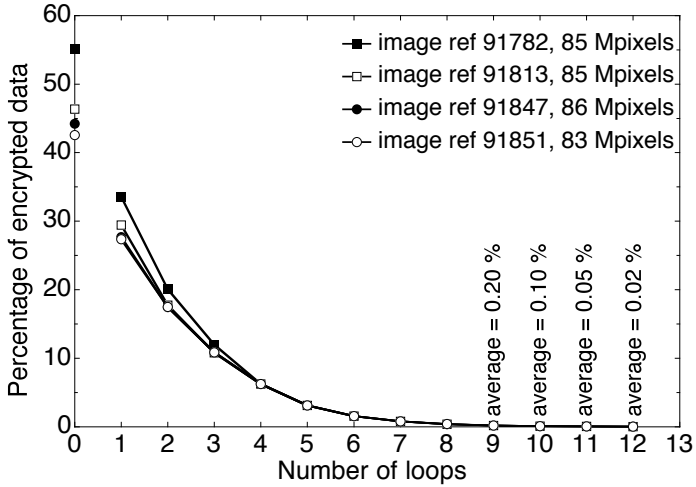
A. Kingston, S. Colosimo, P. Campisi, F. Autrusseau, "Lossless Image Compression and Selective Encryption Using a Discrete Radon Transform", IEEE International Conference on Image Processing, ICIP'07, vol. 4, pp. 465-468, San Antonio, TX, USA, 2007.

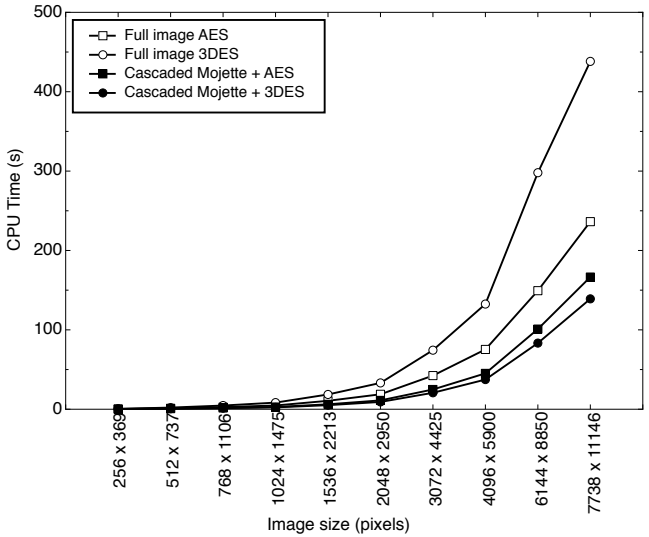
Encryption+Coding with the Mojette.

Results









Conclusion

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- Initially: image watermarking...
- Encountered some issues to watermark the bins, obtain a stable reconstruction and offer sufficient robustness.
- $\rightarrow$ Let's do some encryption.
- Efficient selective encryption methods..
- Encryption+coding.
- + Some other works on Mojette encryption (E. Grall & B. Parrein)

TODOs

- Use Mojette encryption in a distributed storage framework (Fizians)
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Références I


J. Dong, L. Su, Y. Zhang, F. Autrusseau, Y. Zhanbin, "Estimating Illumination Direction of 3D Surface Texture Based on Active Basis and Mojette Transform", SPIE-JEI 2013


C. Zhang, J. Dong, J. Li, F. Autrusseau, "A New Information Hiding Method for Image Watermarking Based on Mojette Transform", ISNNS, 2010


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