Identification du Scanner X à partir d'empreintes du capteur

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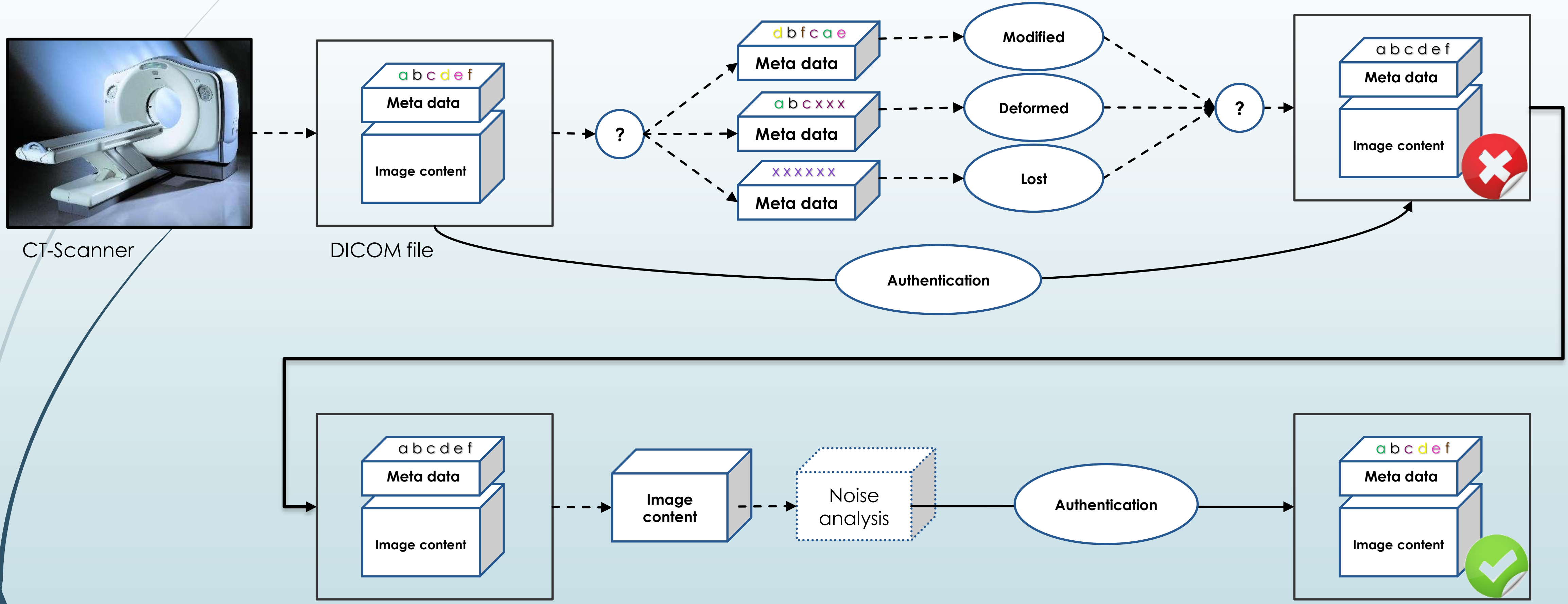
Background



[*] Jerrold T. Bushberg, J. Anthony Seibert, Edwin M. Leidholdt Jr., and John M. Boone, The Essential Physics of Medical Imaging, Third Edition, LWW, third, north american edition edition, 12 2011.
[*] Klaus D. Toennies, Guide to Medical Image Analysis - Methods and Algorithms, Advances in Computer Vision and Pattern Recognition. Springer, 2012.

Outlines

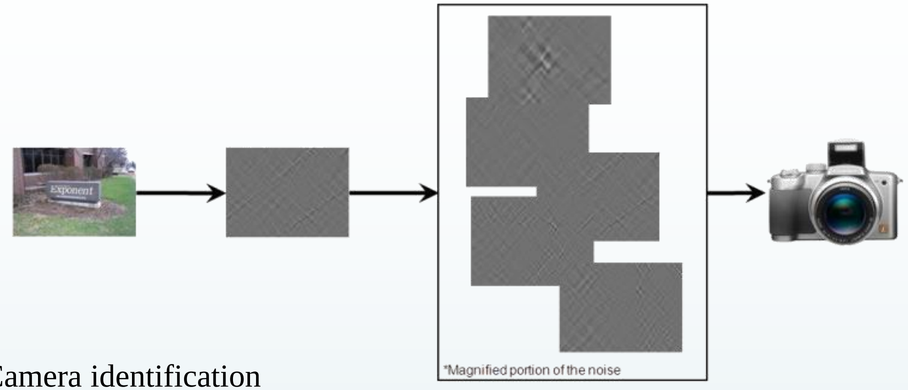
- Background
- **Previous work**
- Our proposed method
- Experimental results
- Conclusion and future work

Previous work

Digital images:

- Camera Identification
  - [1], [2]: Statistical features studies
  - [3], [4], [5]: Photo response non-uniformity
  - [6]: Improved PRNU

- Digital flatbed scanner
  - [7]: Frequency domain
  - [8]: Spatial domain



Camera identification

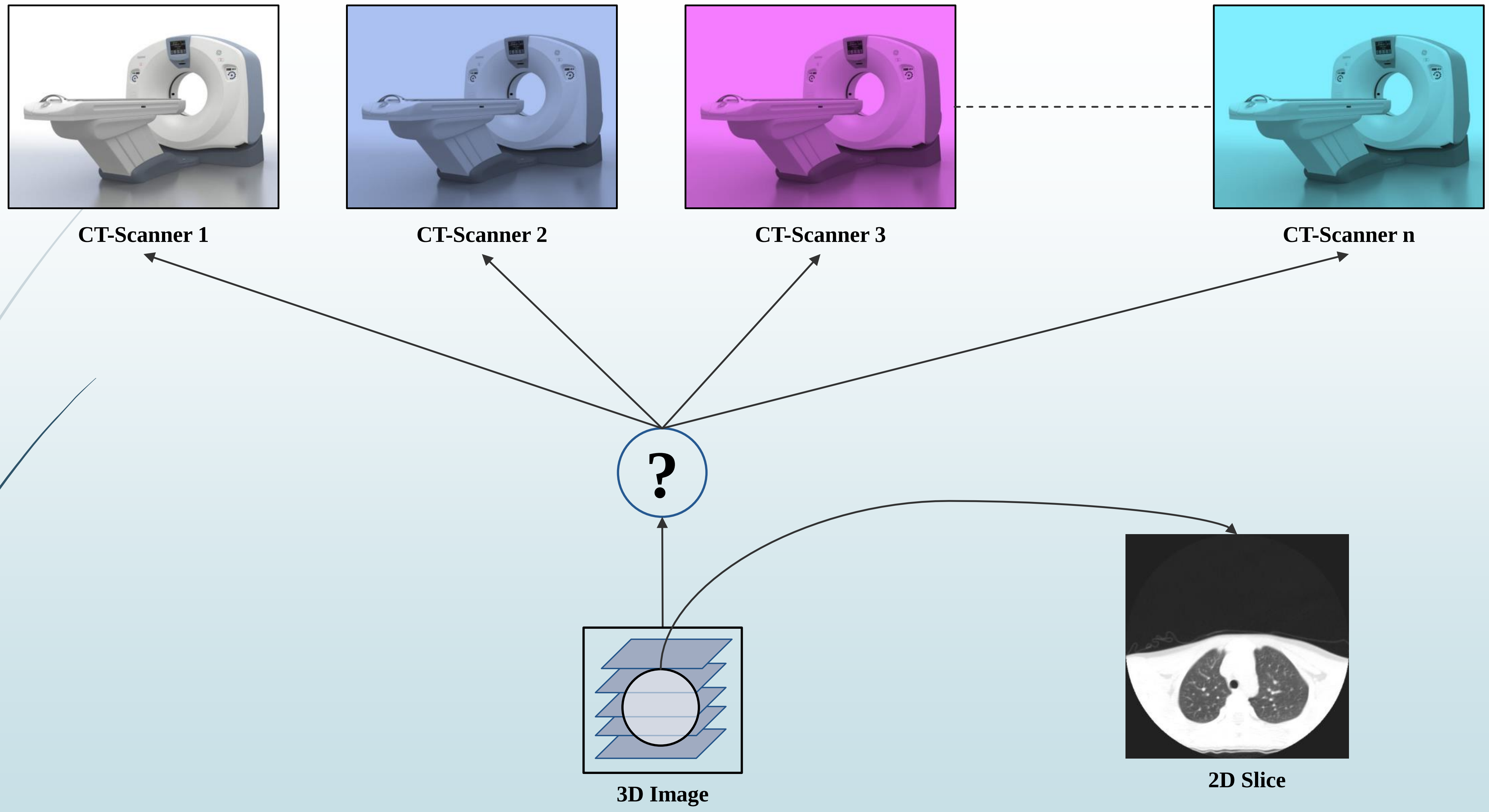
[1] O. Celiktutan, ˙I. Avcibas¸, B. Sankur, and N. Memon, "Source cellphone identification," IEEE Signal Processing and Communications Applications, pp. 1–3, April 2006.
[2] M. Kharrazi, H.T. Sencar, and N. Memon, "Blind source camera identification," in Image Processing, 2004. ICIP '04. 2004 International Conference on, Oct 2004, vol. 1, pp. 709–712 Vol. 1.
[3] J. Lukas, J. Fridrich, and M. Goljan, "Digital camera identification from sensor pattern noise," IEEE Transactions on Information Forensics and Security, vol. 1, no. 2, pp. 205–214, 2006.
[4] M. Chen, J. Fridrich, M. Goljan, and J. Luk´as, "Determining image origin and integrity using sensor noise," Information Forensics and Security, IEEE Transactions on, vol. 3, no. 1, pp. 74–90, 2008.
[5] X. Kang, Y. Li, Z. Qu, and J. Huang, "Enhancing source camera identification performance with a camera reference phase sensor pattern noise," Information Forensics and Security, IEEE Transactions on, vol. 7, April 2012.
[6] C. T. Li, "Source camera identification using enhanced sensor pattern noise," Trans. Info. For. Sec., vol. 5, no. 2, pp. 280–287, 2010.
[7] N. Khanna, A. K. Mikkilineni, G. T.-C. Chiu, J. P. Allebach, and E. J. Delp, "Scanner identification using sensor pattern noise," in SPIE Conference on Security, Steganography, and Watermarking of Multimedia, 2007, vol. 6505.
[8] C.-H. Choi, M.-J. Lee, and H.-K. Lee, "Scanner identification using spectral noise in the frequency domain," in Image Processing (ICIP), 2010 17th IEEE International Conference on, Sept 2010, pp. 2121–2124.

Previous work

Medical images:

- [1]: Noise characteristics in CT-Scanner manufactures.
- [2]: Device identification in 2D radiography images.
- [3]: CT-Scanner identification based on sensor pattern noise.
- [4]: CT-Scanner identification based on reconstruction algorithm.

[1] J. B. Solomon, O. Christianson, and E. Samei, "Quantitative comparison of noise texture across CT scanners from different manufacturers," Medical physics, vol. 39, no. 10, pp. 6048–55, October 2012.
[2] Y. Duan, G. Coatrieux, and H. Shu, "Identification of digital radiography image source based on digital radiography pattern noise recognition," in Image Processing (ICIP), 2014 IEEE International Conference on. IEEE, 2014, pp. 5372–5376.
[3] A. Kharboutly, W. Puech, G. Subsol, and D. Hoa, "Ct-scanner identification based on sensor noise analysis," in Visual Information Processing (EUVIP), 2014 5th European Workshop on. IEEE, 2014, pp. 1–5.
[4] Y. Duan, G. Coatrieux, and H. Shu, "Identification of digital radiography image source based on digital radiography pattern noise recognition," in Image Processing (ICIP), 2014 IEEE International Conference on. IEEE, 2014, pp. 5372–5376.


CT-Scanner 1
CT-Scanner 2
CT-Scanner 3
CT-Scanner n
?
3D Image
2D Slice

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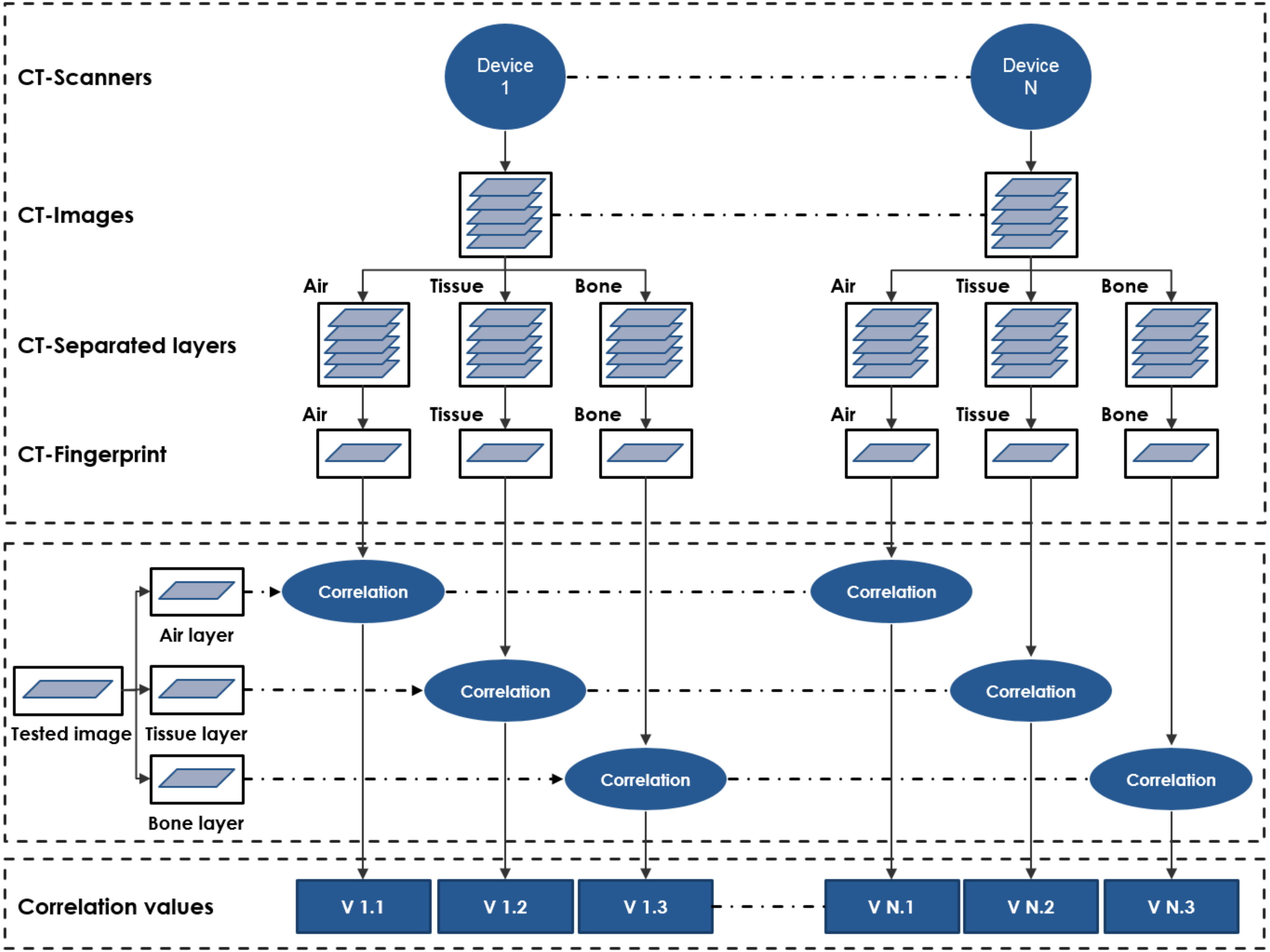


CT-Scanners
Device 1
Device N
CT-Images
Air
Tissue
Bone
CT-Separated layers
Air
Tissue
Bone
CT-Fingerprint
Correlation
Air layer
Tested image
Tissue layer
Bone layer
Correlation values
V 1.1
V 1.2
V 1.3
V N.1
V N.2
V N.3

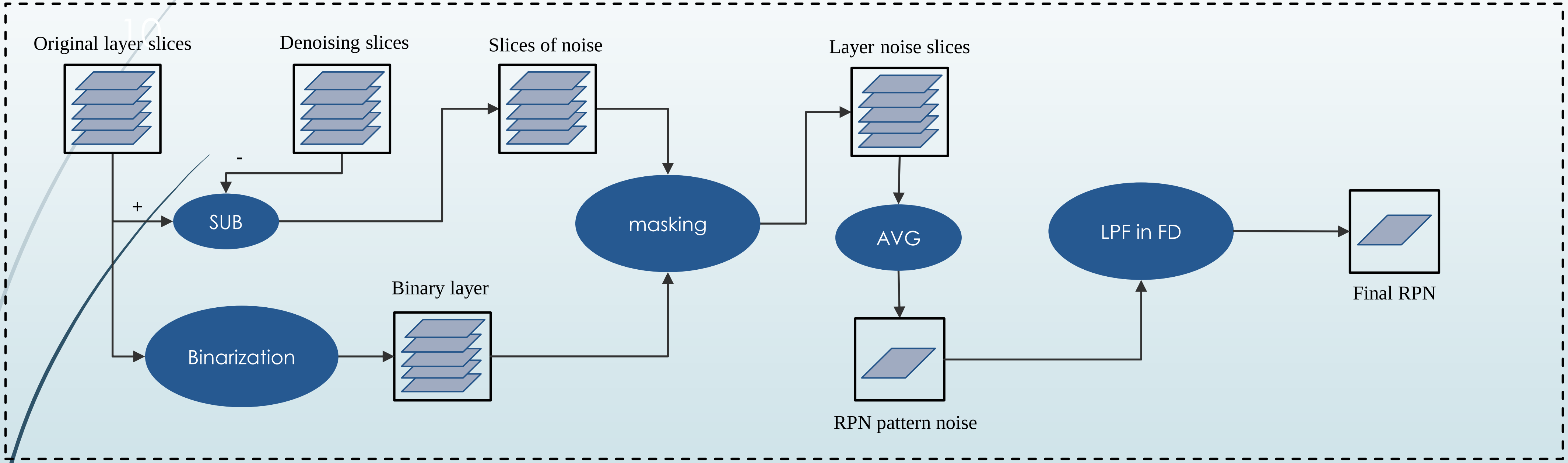
Separation into layers

$$A(i,j) = I(i,j) | I(i,j) \in [a,b],$$
$$T(i,j) = I(i,j) | I(i,j) \in]b,c],$$
$$B(i,j) = I(i,j) | I(i,j) \in]c,d],$$

A: Air image, T: Tissue image, B: Bone image

[20] G. N. Hounsfield, “Computed medical imaging.,” Journal of computer assisted tomography, vol. 4, no. 5, pp. 665–674, 1980.

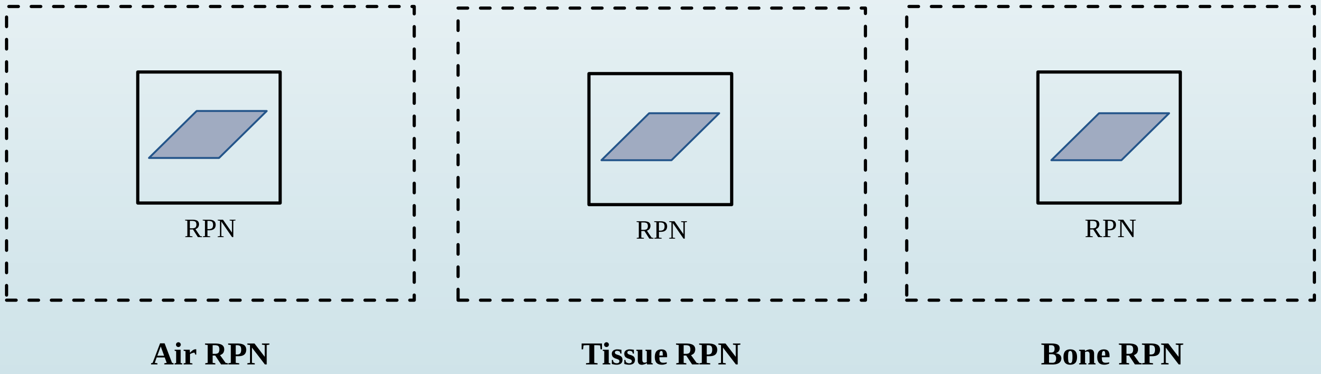
For each layer



For each device

11

Three layer RPNs



Noise extraction

Extract the noise component for the tested slice

$$n = s - F(s)$$

n: noise component

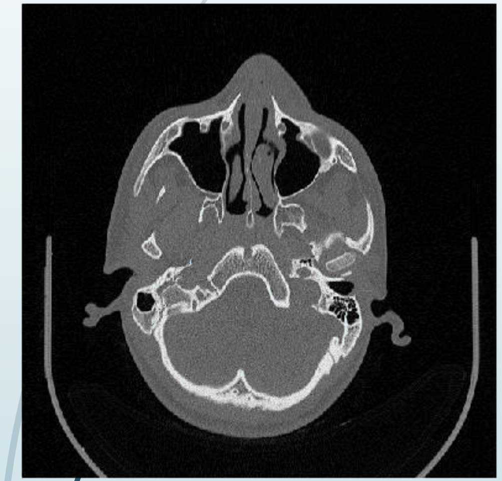
s: slice

F(): denoising function[1-4]

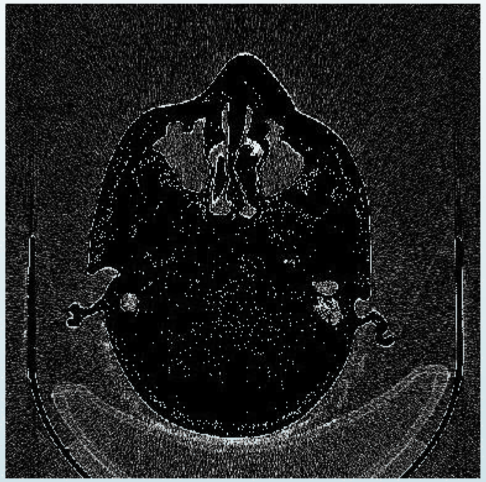
[1] M.K. Mıhc¸ak, I Kozintsev, and K. Ramchandran, “Spatially adaptive statistical modeling of wavelet image coefficients and its application to denoising,” in Acoustics, Speech, and Signal Processing, 1999. Proceedings., 1999 IEEE International Conference on, Mar 1999, vol. 6, pp. 3253–3256.
[2] E. Jerhotov´a, A. Proch´azka, and J. ˇ Svihl´ık, Biomedical image volumes denoising via the wavelet transform, INTECH Open Access Publisher, 2011.
[3] P. Gravel, G. Beaudoin, and J. A. De Guise, “A method for modeling noise in medical images,” Medical Imaging, IEEE Transactions on, vol. 23, no. 10, pp. 1221–1232, 2004.
[4] N. Jacob and A. Martin, “Image denoising in the wavelet domain using Wiener filtering,” Unpublished course project, 2004, [Online], Project Report, Available: http://homepages.cae.wisc.edu/ece533/project/f04/jacob martin.pdf.

Noise extraction

Example: Original image of head and its three layers

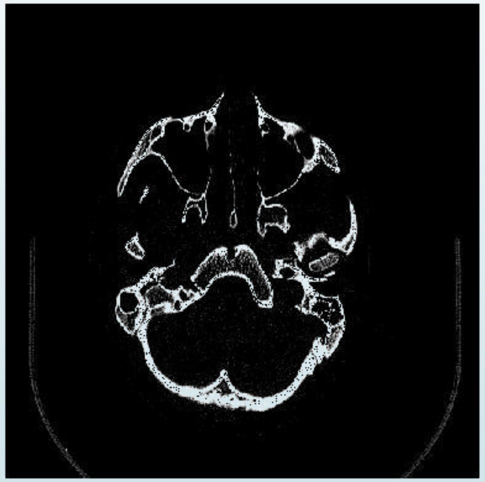


a) Original



b) Air layer

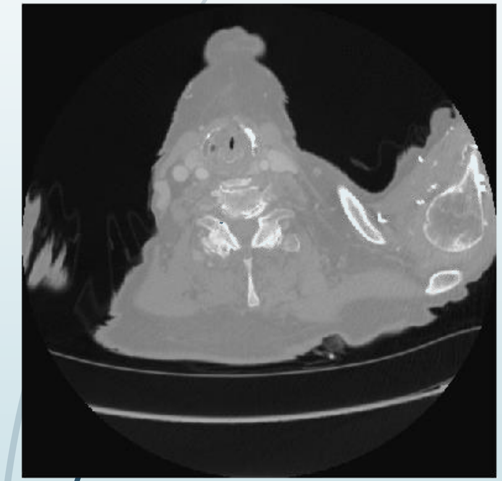
c) Tissue layer



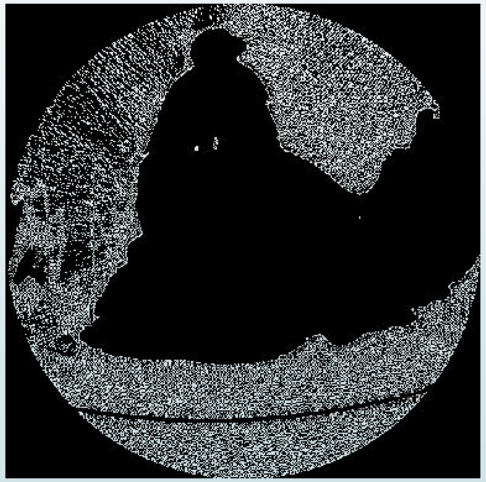
c) Bone layer

Noise extraction

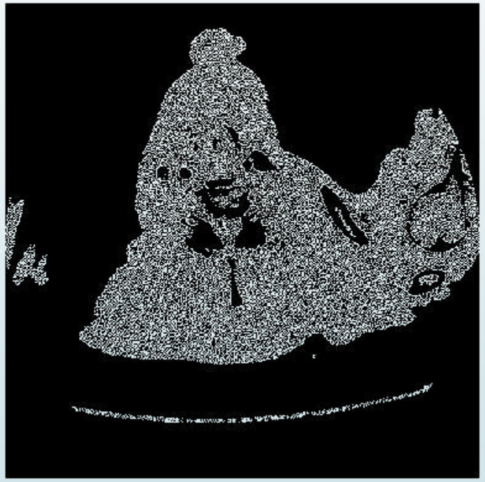
Example: Original image of thorax and its three noise layers



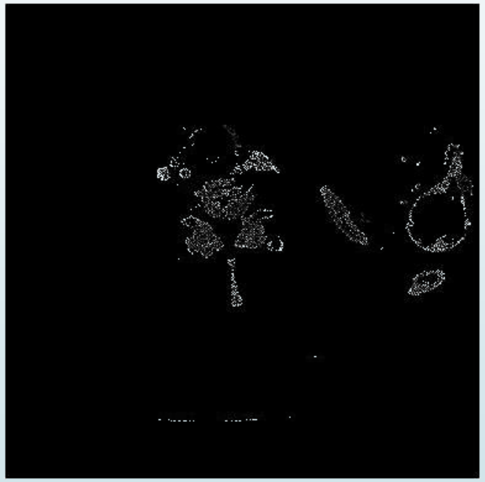
a) Original



b) Air layer



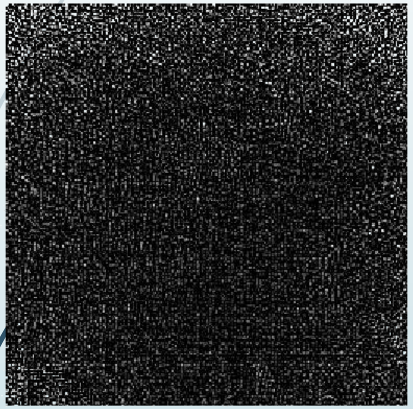
c) Tissue layer



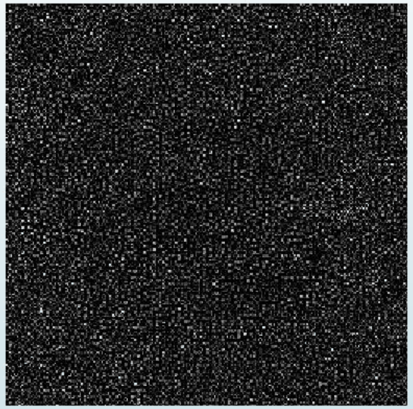
c) Bone layer

RPN

Example: RPNs from three different CTs using different layers:



S1: Air RPN



S2: Tissue RPN

GE: Bone RPN

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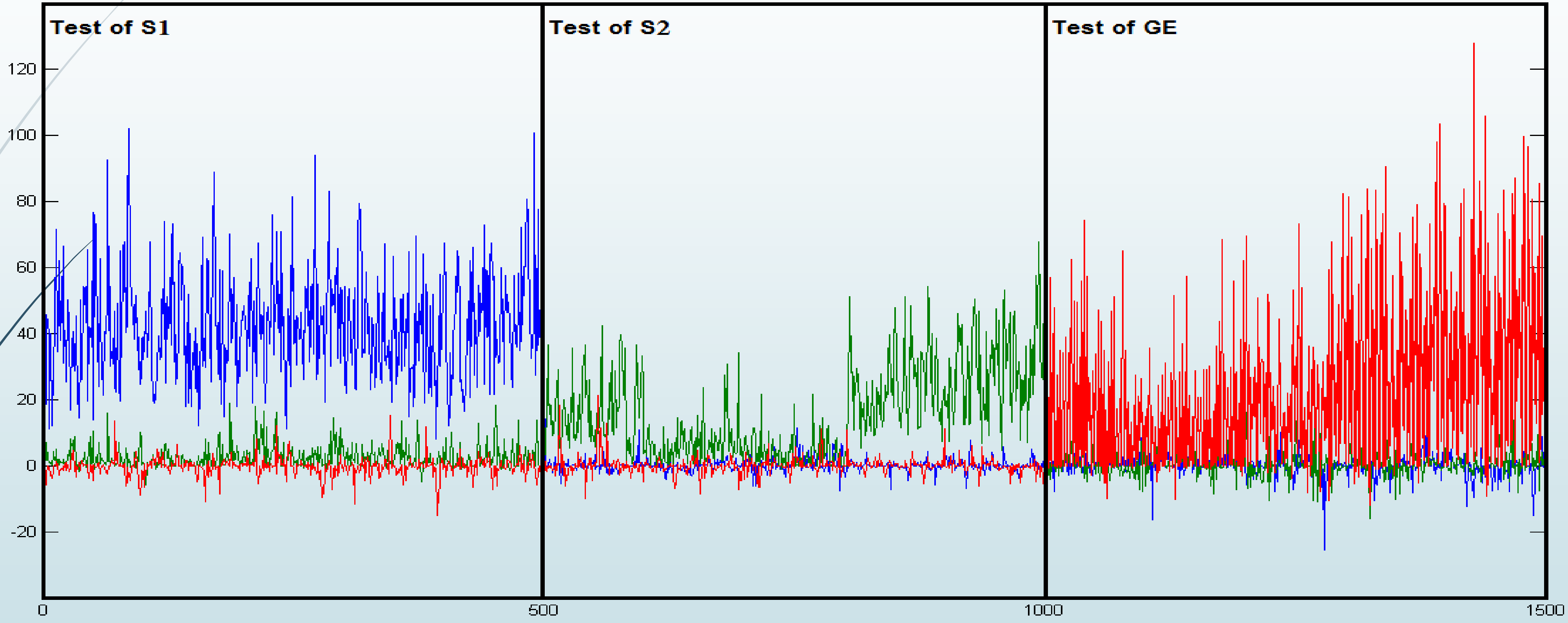
Experimental images

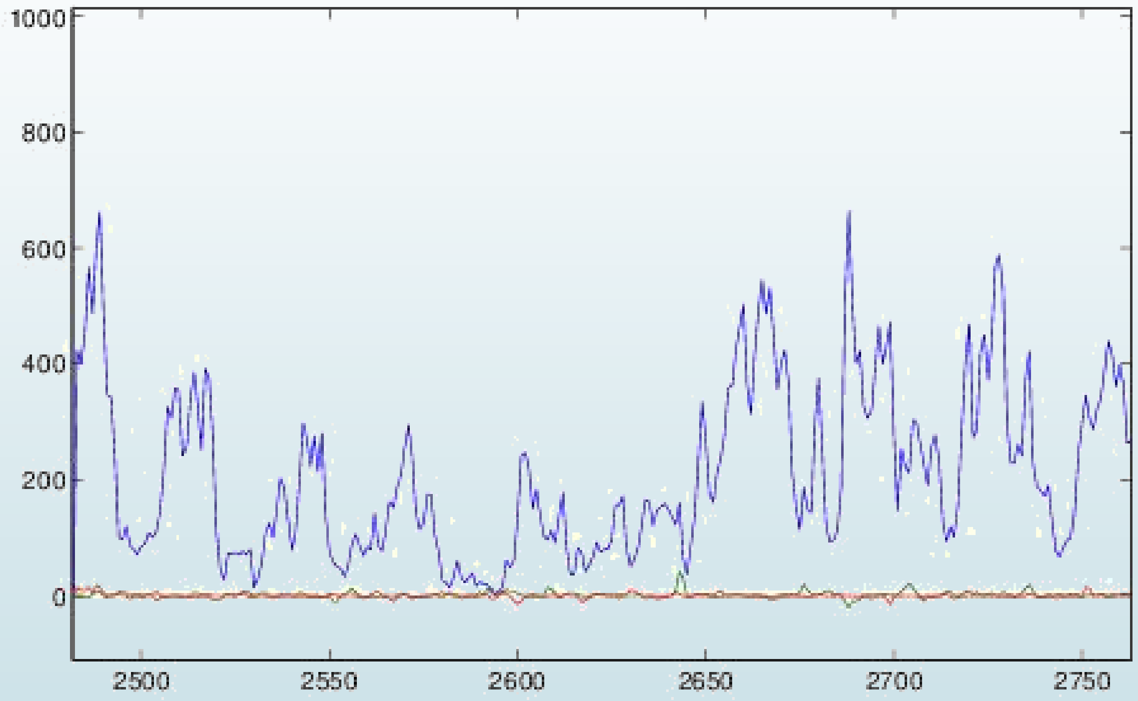
	Siemens 1	Siemens 2	GE
Nb of 3D volumes	20	20	20
Nb of images	7572	7279	5088
Size (pixels)	512x512	512x512	512x512
Bits per pixel	16	16	16
Nb of images to compute RPN	3363	3756	2092
Nb of tested images	4209	4523	2996

Results



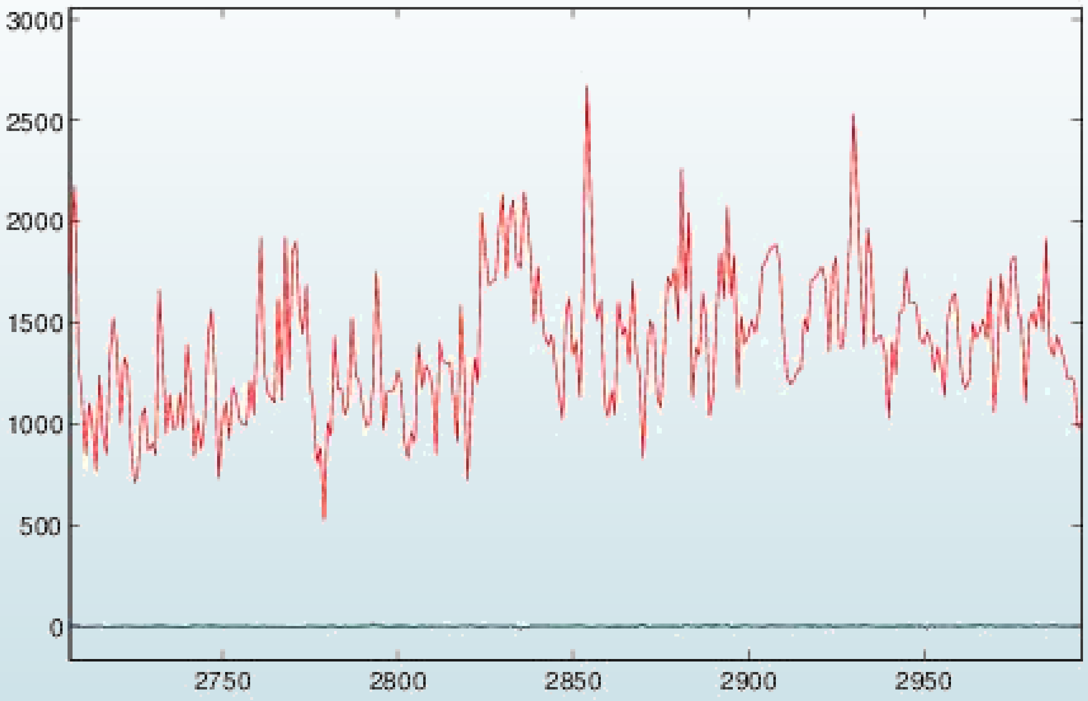
Test slices of tissue layer from three CT-Scanners

Results



Test slices of bone layer from Siemens 1

Results



Test slices of air layer from General Electric

Identification accuracy

	Siemens 1	Siemens 2	GE	No ID
Siemens 1	**81.23** %	9.29 %	3.23 %	6.25 %
Siemens 2	4.75 %	**83.63** %	4.24 %	7.38 %
GE)	5.27 %	4.03 %	**81.81** %	8.89 %

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Conclusion

- A new direction for medical device identification.
- Applied on real data.
- High identification performance.

Future work

- Possibility of attacking this kind of RPN.
- Influence of image modification.
- Influence image compression on our proposed

Thank you for your attention

Identification du Scanner X à partir d'empreintes du capteur