MR / Clinical white paper

Precise IQ Engine (PIQE) in Clinical Practice

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The Rothschild Foundation Hospital in Paris is a non-profit hospital pioneering care, research, and cooperation on ophthalmic and brain diseases. The hospital's Neuroradiology Department is continually involved in advanced research, using cutting-edge imaging techniques and Artificial Intelligence (AI) based solutions.

Triangle of compromises

In medical imaging, image quality is crucial for diagnosis because it drives the confidence in the radiologist's diagnosis. There are many factors impacting the image quality. A classic representation, called "triangle of compromises", is often used to illustrate the close relation between the signal-to-noise ratio (SNR), image resolution and scan time (Figure 1). A change in one of them directly impacts the other two. For example, if the spatial resolution is increased without increasing the scan time, SNR drops, and image quality is affected.

At the Rothschild Foundation Hospital, we use Deep Learning Reconstruction (DLR) techniques in our clinical practice every day, such as Canon's Advanced intelligent Clear-IQ Engine (AiCE) and the latest Precise IQ Engine (PIQE) to overcome these limitations.

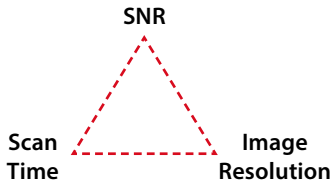

Figure 1 "Triangle of compromises" illustration highlighting the close relationship between SNR, image resolution and scan time.

PIQE method

PIQE is a reconstruction tool that combines two unique steps: denoising and upsampling (Figure 2). The role of the denoising step (blue circle) is to increase SNR. To do so, an AI-based algorithm is applied to selectively remove noise without affecting signal. The denoised images are then converted into k-space to proceed to the upsampling step (red circle), where the image matrix size is expanded by a zero-filling process (up to 3 times in each of the in-plane dimensions). Finally, PIQE performs a second AI-based algorithm which has been trained to selectively reduce ringing artifacts (or Gibbs Ringing), which may appear around interfaces between structures when a high level of resolution expansion is applied (Figure 3).

User interface options

PIQE includes four adjustable parameters: (1) the denoising strength (DL Recon Adjust); (2) the retention of a natural feeling (Denoise Levels); (3) the multiplicative upsampling factor that is applied to both the phase and readout matrices (Zoom Ratio) and (4) the option to enhance structure contours (Edge Enhancement). Users can then fine tune the reconstruction settings to adjust image quality based on their personal preferences (Figure 4).

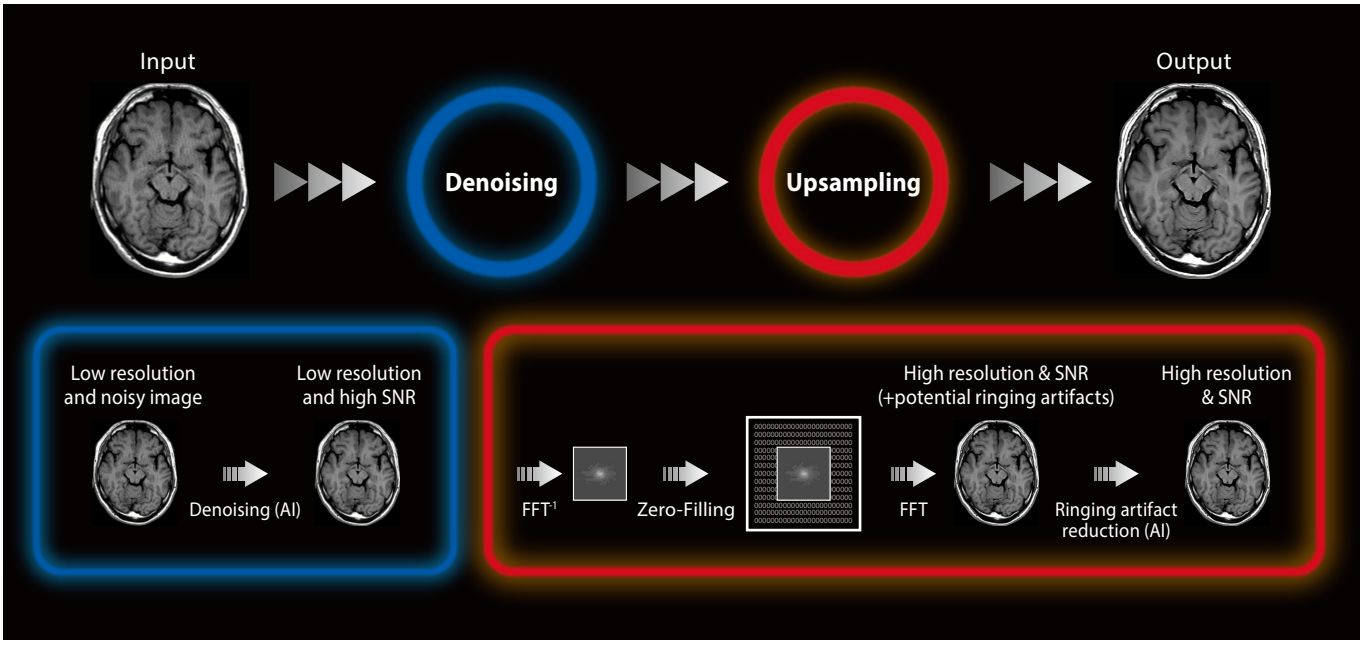

Figure 2 PIQE pipeline including two major steps, denoising and upsampling, leading to high resolution and high SNR images.

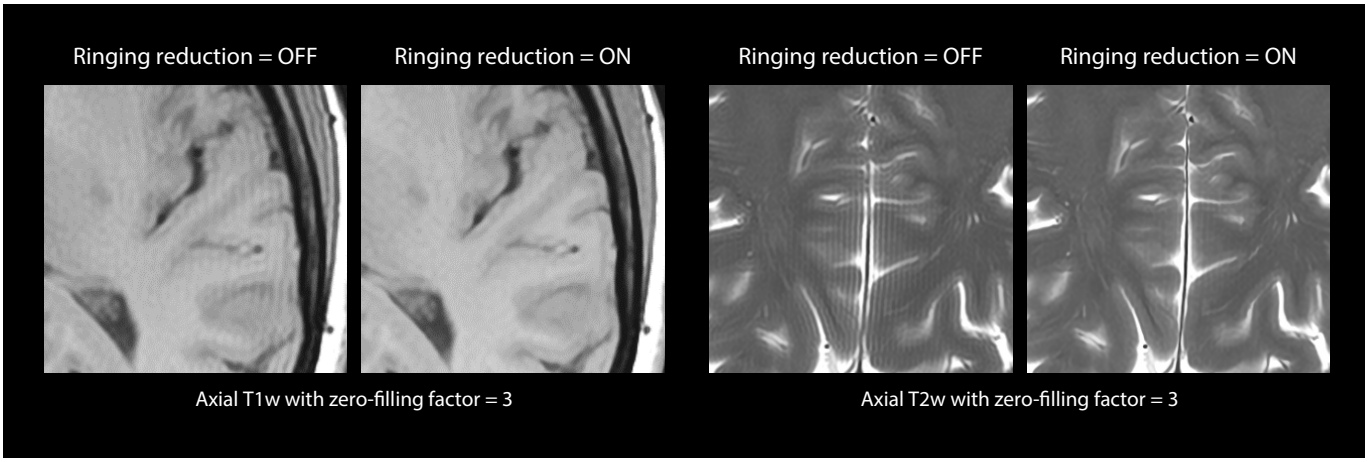

Figure 3 PIQE embeds an AI-based algorithm to reduce Gibbs ringing artifacts emphasized by the upsampling step.

"Thanks to PIQE, the triangle of compromises is totally reconsidered: signal improvement is obtained without any compromises on spatial resolution and scan time."

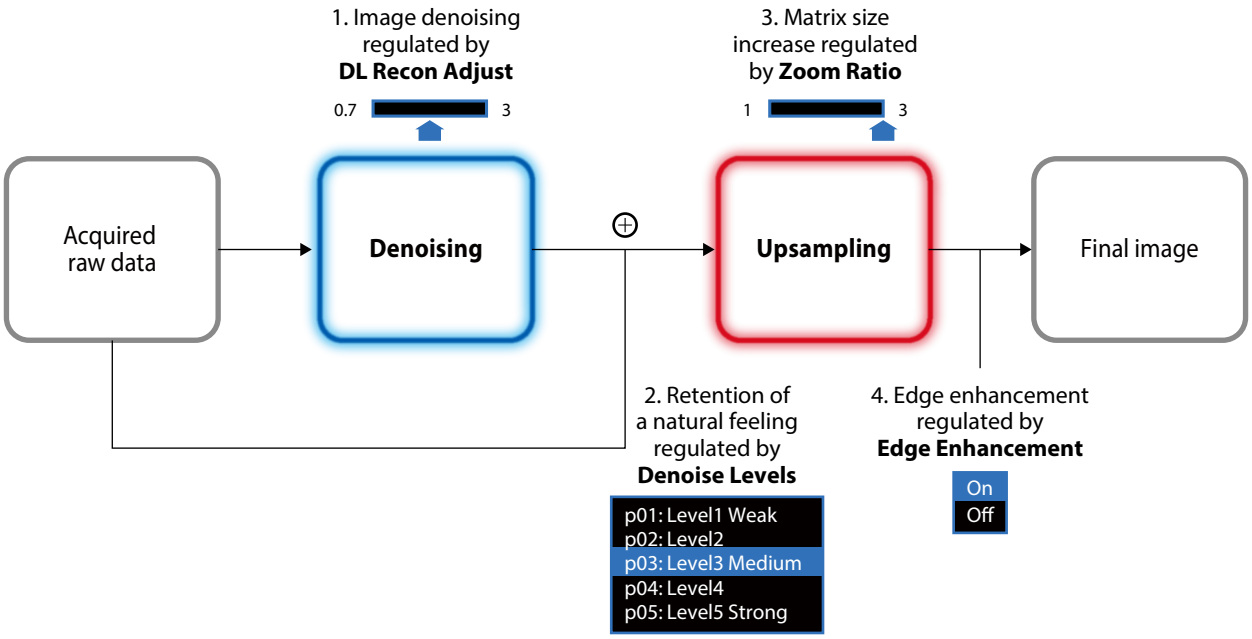

Figure 4 PIQE user interface offers the possibility to adjust four parameters (DL Recon Adjust, Denoise Levels, Zoom Ratio and Edge Enhancement).

PIQE evaluation

To evaluate the PIQE performance in a clinical practice, we have performed a comparative study on several patients suffering from neurological diseases, such as multiple sclerosis (Figure 5) or degenerative cervical spine (Figure 6). We found out that SNR and perceived sharpness were clearly improved on PIQE images. Structures were far crisper, lesions were more visible with a better contour depiction and a greater diagnostic confidence was achieved.

Conclusion

For decades, image quality was improved using filters, always at the cost of information loss (e.g., adding noise or blurring). The recent introduction of DLR has revolutionized the field, allowing image quality improvement without any compromises. PIQE is one of these DLR solutions and has been designed to increase the reconstructed matrix size, providing finer resolution while maintaining or improving SNR. These image sharpness and SNR gains can be used to increase throughput and clinical confidence.

"We can now perform 800 µm isotropic images with a very high image quality on our Vantage Orian 1.5T, which previously was only possible on 3T systems."

Clinical and scientific Canon Medical support

Valentin H. Prevost, Ph.D.
MR Clinical Scientist
Canon Medical Systems Corporation

Multiple sclerosis – 2D T2w 600 × 600 µm² (1:30)

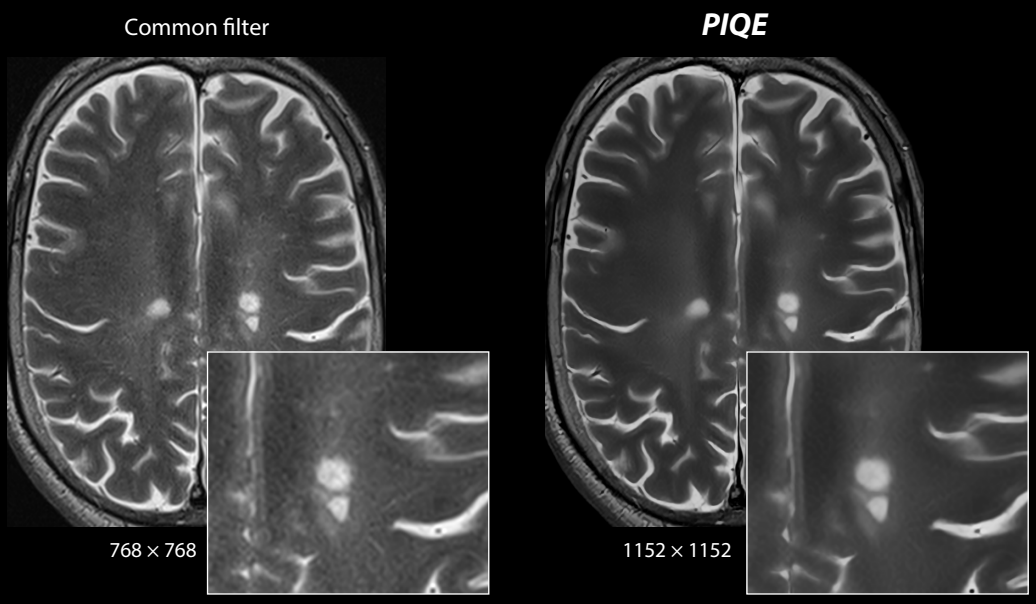

Figure 5 Axial 2D T2w images of a multiple sclerosis patient with a 600 × 600 µm² in-plane resolution. A zoom in has been done on the lesion, to enable appreciation of the highest definition and denoising obtained with PIQE reconstruction.

Degenerative cervical spine – 2D T2w DIXON 400 × 400 µm² (2:15)

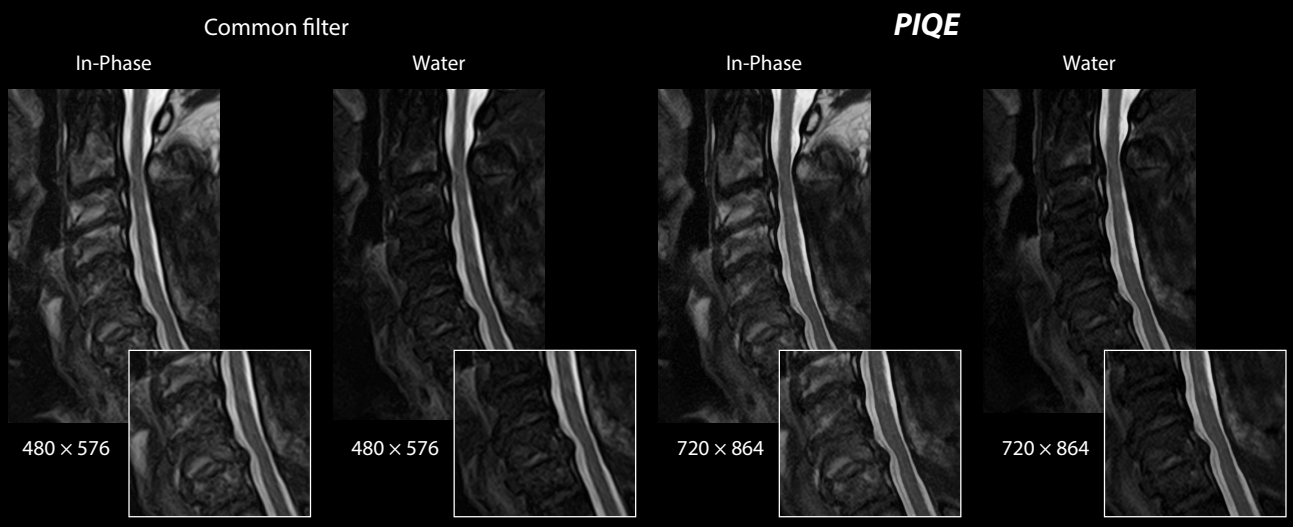

Figure 6 Sagittal T2w Dixon images of a 71-year-old patient with cervical spondylotic myelopathy after surgery. The spinal cord residual high-T2 signal abnormalities in C2-C3, C3-C4 and C4-C5 are better depicted on the PIQE reconstructions. In addition, the sharpness of vertebrae, discs and spinal cord has been greatly improved.

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