

SANA-I2I: A TEXT-FREE FLOW-MATCHING FRAMEWORK FOR PAIRED IMAGE-TO-IMAGE TRANSLATION IN FETAL MRI ARTIFACT REDUCTION

EP15.32

Italo M. Santos ⁴, Gilson Giraldi ⁴, Fatima Leite ^{1,2}, Heron Werner ^{2,3}

1. Pediatrics, Fundacao Oswaldo Cruz (FIOCRUZ), Rio de Janeiro, Brazil.
2. Biodesign Lab Dasa/PUC-Rio, Rio de Janeiro, Brazil.
3. Universidade Federal do Rio de Janeiro (UFRJ), Rio de Janeiro, Brazil.
4. National Laboratory for Scientific Computing (LNCC), Rio de Janeiro, Brazil

🎯 Objective

To introduce SANA-I2I, a new image-to-image method adapted from the SANA generative framework.

📊 Methods

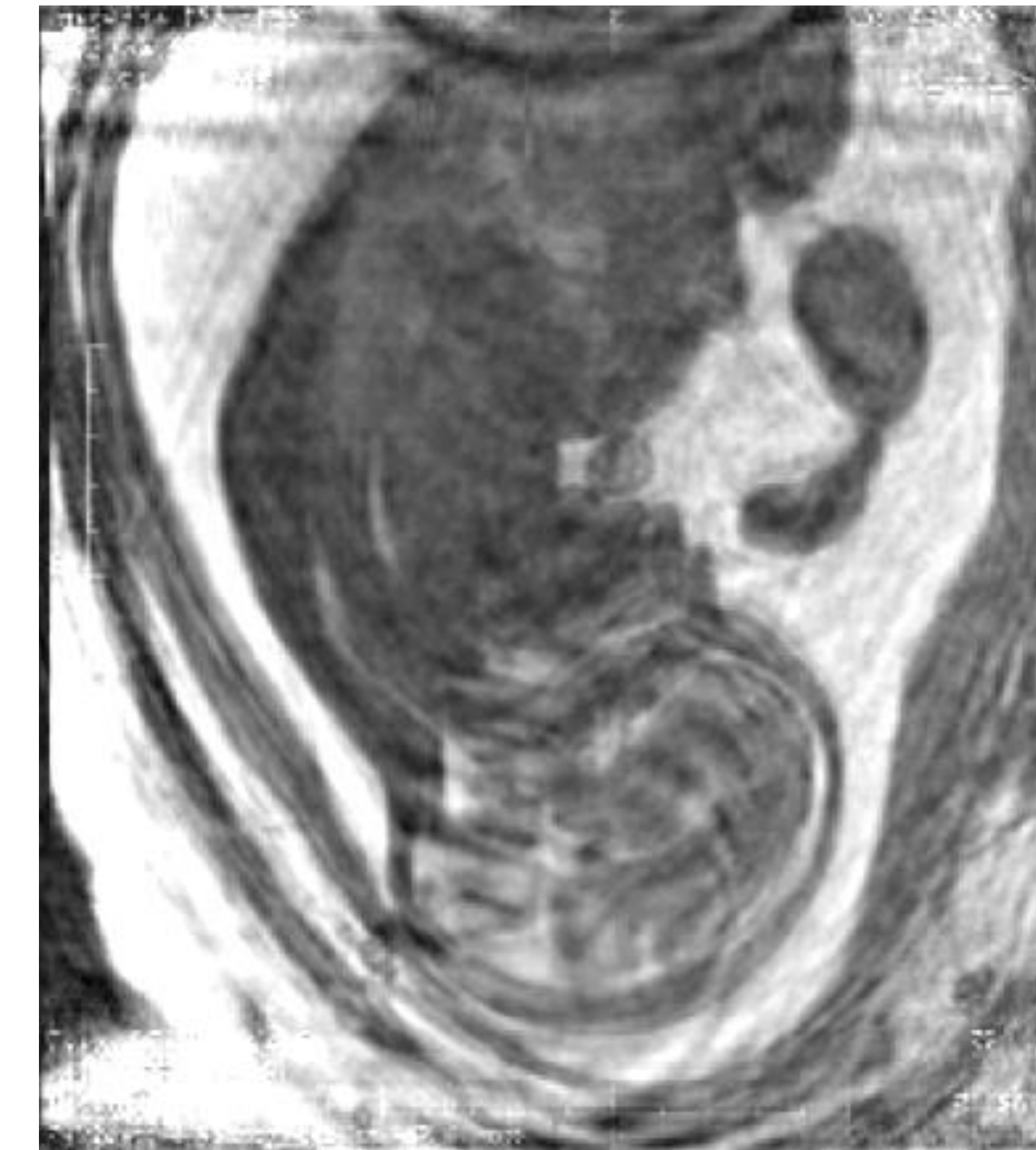
SANA-I2I simplifies the original SANA architecture by removing all text-related components and using the input image as the only source of guidance. The model learns how to transform an artifact-affected image into a cleaner version by studying pairs of corrupted and clean images. Because real fetal MRI cannot be acquired in perfectly matched clean/corrupted pairs, we created synthetic paired data, which simulates realistic motion artifacts by modifying the image in the frequency domain. Training followed the same general strategy as the original SANA system, including its optimization method and resolution settings. The severity of synthetic artifacts was controlled using SSIM thresholds, ensuring that the model was trained on challenging, clinically relevant examples.

📈 Results

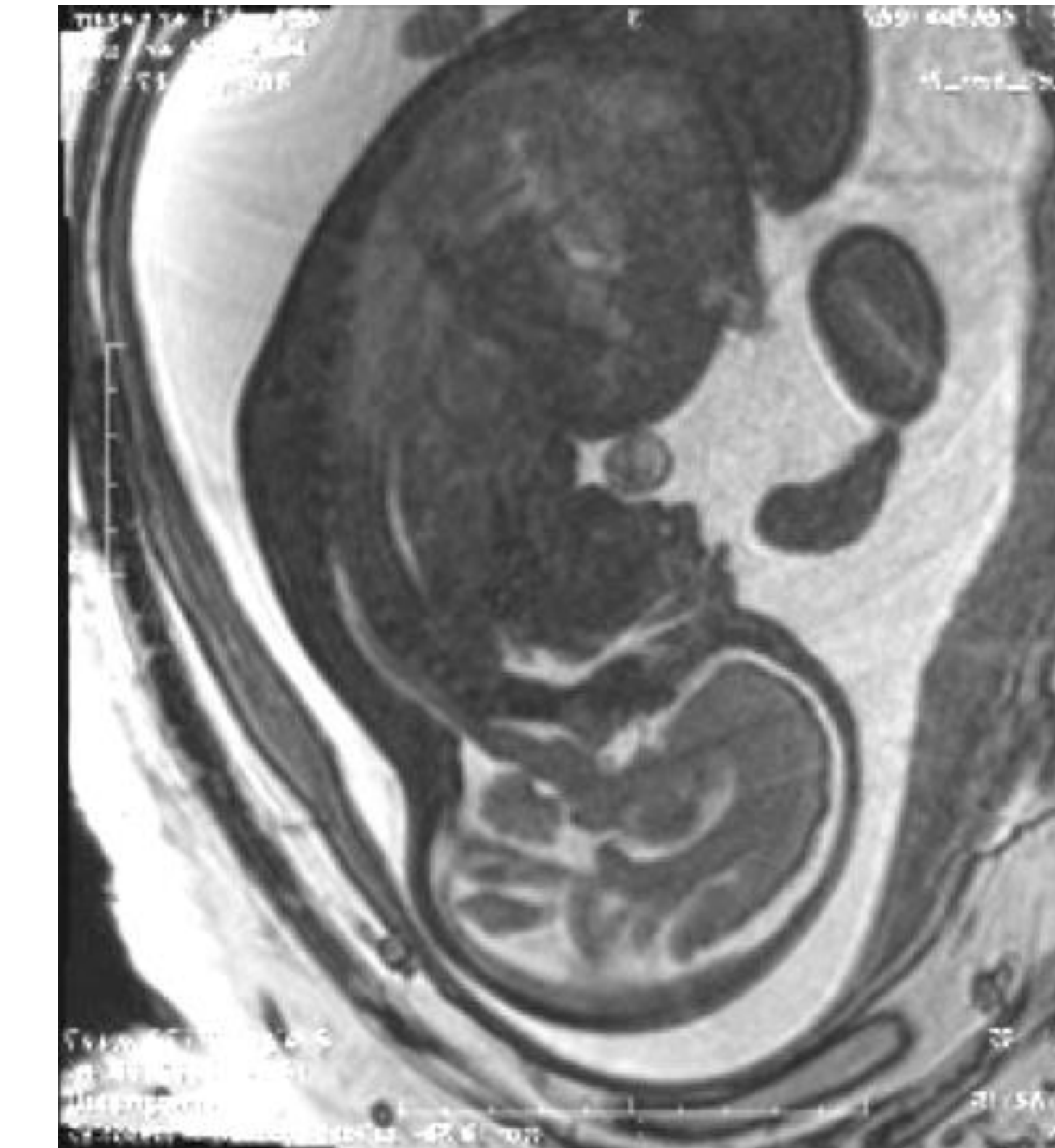
Evaluation was performed using real fetal MRI scans for quantitative and qualitative comparisons. Because real fetal MRI lacks ground-truth clean images, we used distribution-based metrics, which measure how closely the corrected images resemble the appearance of artifact-free fetal MRI. Compared with a previously published GAN-based method (CycleGAN V2), SANA-I2I showed better FID and KID values, indicating that its corrected images are statistically closer to clean reference images. Qualitatively, SANA-I2I reduced motion streaks more effectively, improved anatomical clarity, and preserved realistic brightness and contrast.

🔒 Conclusion

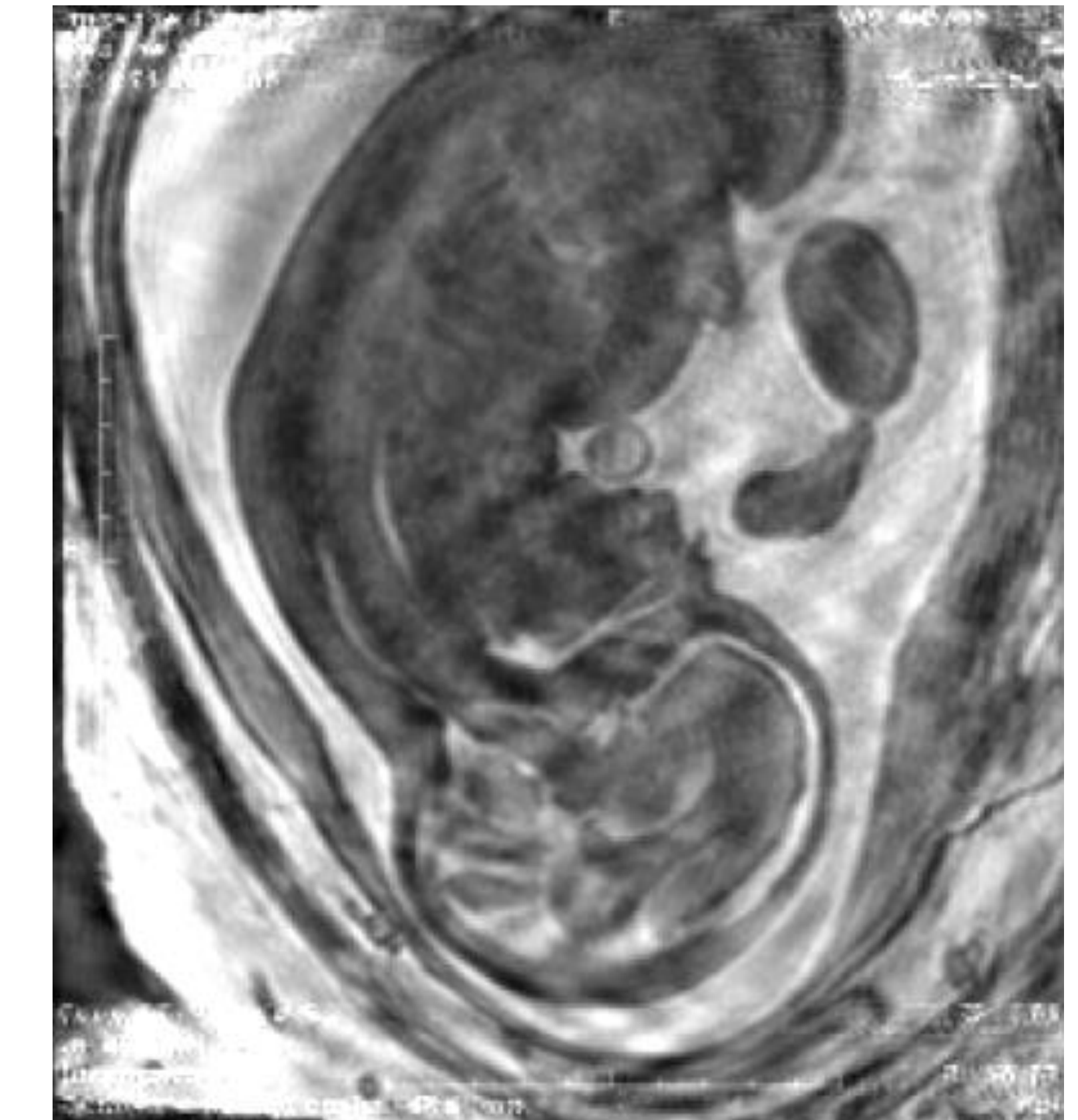
SANA-I2I offers a simple and effective approach for improving fetal MRI affected by motion artifacts. By learning directly from paired training examples and relying only on the input image for guidance, it avoids the limitations of text-based generative models. The method produced reconstructed images that were both visually and statistically closer to clean fetal MRI, demonstrating strong potential for clinical imaging applications. Although evaluated here in fetal MRI, SANA-I2I is general and can be applied to any task where paired images are available, including other areas of medical and non-medical imaging.



(a)



(b)



(c)

Since the original method does not provide good results, we simulate the artifact motion to generate some paired data using the method and help the Cycle GAN by adding an additional L1 loss on its loss function that only receives synthetically generated data free of artifact images. In the bellow image, images (b)-(c) were generated from image (a) using our method.