Perceived quality measurement of low-dose lung CT after retrospective neural network image enhancement

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Objective
Image quality and reliability are critical for both diagnostic assessment and quantitative analysis of medical images. Emphysema screening or interstitial lung diseases are usually visually assessed using low dose CT (LDCT) and it is important for any enhancement technique to maintain the quality of the images. Most quantitative measures for image quality use 2D features, while for many diseases, 3D features are an important tool for assessment. The structural similarity index measurement (SSIM) will allow us to assess image quality without losing information added by using 3D images. Another advantage of SSIM is that it is a strong measurement tool for luminance and contrast. Aim of this work is to use SSIM to analyse the visual image quality of LDCT after an artificial neural network image enhancement technique.

Methods:
24 LDCT were randomly selected from a population based lifeline cohort with different reconstruction kernel Br40 & QR59. All LDCT images are enhanced using artificial neural network technique (Pixelshine-AlgoMedica, Palo alto, California, USA). The image quality assessment between original LDCT and the enhanced LDCT consisted of three parts. First, the strong dependencies amongst pixels and its neighbouring pixels are measured both in 2D and 3D by using the SSIM. Next, we measure the error sensitivity with peak signal-to-noise ratio (PSNR) and mean squared error (MSR) between the original and enhanced image with respect to each reconstruction kernel separately. Finally, the enhancement technique was applied multiple times and PSNR and SSIM measured between the images that are enhanced once and the ones that are enhanced twice.

Results:
Mean values of the SSIM index were good in 2D and 3D between the original and processed images (0.9945 and 0.8845 respectively). Average of PSNRs measured between the original and post-processed images is good (77.41 dB) and the MSRs remained negligible. The SSIM between images once and double processed was 0.9982 for the 2D and 0.8699 for the 3D.

Conclusions:
The SSIM and PSNR values measured between reference and enhanced image showed quality improvement with respect to the reference image. According to results, the artificial neural network image enhancement technique may improve the image quality without inducing noticeable changes to the original image. Furthermore, the enhancement technique can be reiterated for a greater effect. Clinical effect on the diagnostics of homogeneity and heterogeneity in emphysema has to be further explored.

References: