

Computing contrast ratio in medical images using local content information*

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Rationale

Image quality assessment in medical applications is often based on quantifying the visibility between a structure of interest such as a vessel, termed foreground (F) and its surrounding anatomical background (B), i.e., the contrast ratio. A high quality image is the one that is able to make diagnostically relevant details distinguishable from the background. Therefore, the computation of contrast ratio is an important task in automatic medical image quality assessment.

Methods

We estimate the contrast ratio by using Weber's law in local image patches. A small image patch can contain a flat area, a textured area or an edge. Regions with edges are characterized by bimodal histograms representing B and F, and the local contrast ratio can be estimated using the ratio between mean intensity values of each mode of the histogram. B and F are identified by computing the mid-value between the modes using the ISODATA algorithm. This process is performed over the entire image with a sliding window resulting in a contrast ratio per pixel.

Results

We have tested our measure on two general purpose databases (TID2013 [1] and CSIQ [2]) to demonstrate that the proposed measure agrees with human preferences of quality. Since our measure is specifically designed for measuring contrast, only images exhibiting contrast changes are used. The difference between the maximum of the contrast ratios corresponding to the reference and processed images is used as a quality predictor. Human quality scores and our proposed measure are compared with the Pearson correlation coefficient. Our experimental results show that our method is able to accurately predict changes of perceived quality due to contrast decrements (Pearson correlations higher than 90%). Additionally, this method can detect changes in contrast level in interventional x-ray images acquired with varying dose [3]. For instance, the resulting contrast maps demonstrate reduced contrast ratios for vessel edges on X-ray images acquired at lower dose settings, i.e., lower distinguishability from the background, compared to higher dose acquisitions.

Conclusions

We propose a measure to compute contrast ratio by using Weber's law in local image patches. While the proposed contrast ratio is computationally simple, this approximation of local content has shown to be useful in measuring quality differences due to contrast decrements in images. Especially, changes in structures of interest due to low contrast ratio can be detected by using the contrast map making our method potentially useful in X-ray imaging dose control.

References

- [1] Ponomarenko N. et.al., "A New Color Image Database TID2013: Innovations and Results," Proceedings of ACIVS, 402-413 (2013).
- [2]. Larson E. and Chandler D., "Most apparent distortion: full-reference image quality assessment and the role of strategy," Journal of Electronic Imaging, 19 (1), 2010.
- [3] Kumcu, A. et.al., "Interventional x-ray image quality measure based on a psychovisual detectability model," submitted to MIPS XVI, Ghent, Belgium, 2015.

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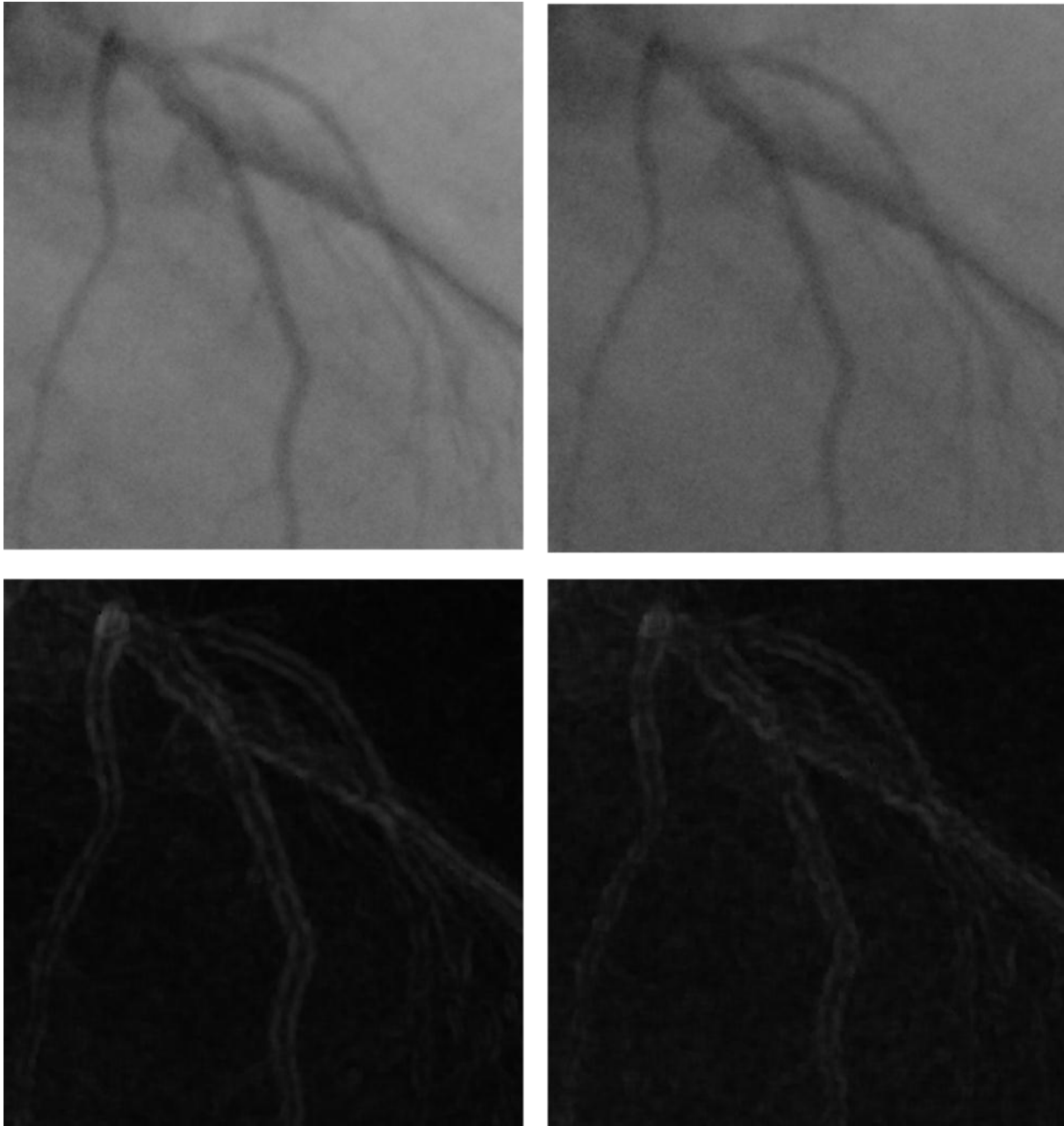


Figure 1 (Top) Crop of high quality (left) and low quality (right) cardiac X-ray image. (Bottom) Contrast ratios of X-ray images. Brighter gray value means higher contrast ratio. Visual inspection of the contrast map around structures of interest in these images demonstrates that some structures of interest (vessel edges) are more difficult to detect (visually) which is represented by lower contrast ratios around the edges.

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