A Motion based Video Quality Metric for Cardiac Ultrasound Videos

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Rationale

Medical video quality evaluation is often done using state of the art video quality metrics which mainly assess the perceptual quality of the video without considering the aspect of diagnostic quality. A diagnostic-quality oriented medical video quality metric can be beneficial in medical video quality evaluation. One of the ways of achieving diagnostic quality oriented evaluation is developing content-aware video quality metrics. Towards this approach, we propose a full reference, content-aware video quality metric designed for quality evaluation of cardiac ultrasound videos. The proposed metric considers the motion information of each cardiac cycle of the ultrasound video to evaluate the diagnostic quality.

Materials and Methods

The Horn and Schunck optical flow method is used to estimate the magnitude of the motion vectors of each pixel of a frame of both the reference video and the impaired video. A weighted response for each pixel of a frame is obtained by applying a Gaussian weighting function to each pixel of a frame of the video using a window based approach. The mean squared error for each frame between the reference and the impaired video is computed for all the frames in a single cardiac cycle and represents the error index for that cardiac cycle. The maximum of the error indices from all the cardiac cycles is then used to represent the quality measure of the cardiac ultrasound video. The proposed metric was tested on 24 cardiac ultrasound videos, i.e. three videos compressed at eight different quality levels, using the High Efficiency Video Coding (HEVC) standard. Subjective quality evaluation of the videos was done by four medical experts. The proposed metric scores were correlated with the subjective scores of the medical experts. Further, the correlation scores of the proposed metric were compared with seven state-of-the-art video quality metrics.

Results

The results of our experiments found that the proposed metric shows consistently high correlation with the subjective scores. The proposed metric also outperforms most of the state-of-the-art metrics considered in our tests. The Pearson correlation and the Spearman correlation of the proposed metric with subjective scores of the medical experts were found to be 0.94 and 0.93 respectively. On the other hand, correlation scores of the popular metrics like SSIM, PSNR, and VQM were 0.93, 0.90, and 0.92 respectively (Pearson Correlation).

Conclusions

The proposed metric presents a diagnostic-quality oriented video quality metric for cardiac ultrasound videos. The results of our tests showed that the motion in cardiac ultrasound videos can be effectively utilized for a reliable objective evaluation of diagnostic quality. The approach of using specific characteristics of the medical video can enable design and development of more diagnostic-quality oriented video quality metrics.