Visually Lossless Compression of Chest X-ray Images

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Overview

- **Introduction**: prior work & project overview
- **Method**: noise analysis & compression approach
- **Results**: dataset, experiments, outcomes

Introduction

Related Work

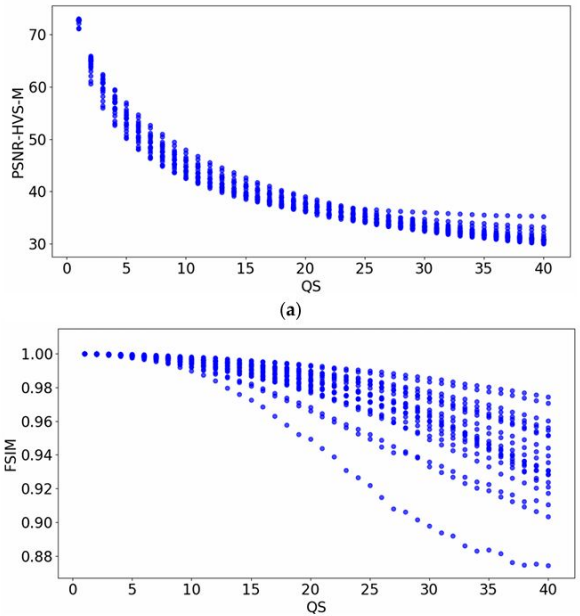
A Fast Method of Visually Lossless Compression of Dental Images

- Dental images
- Visually-lossless
- Compression efficiency

Goal

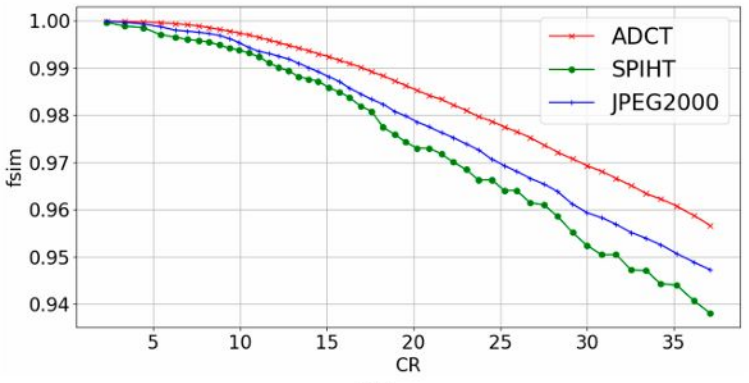
Determine optimal Quantization Step (QS)

- Ensure visually-lossless output
- Maximize compression ratio without harm



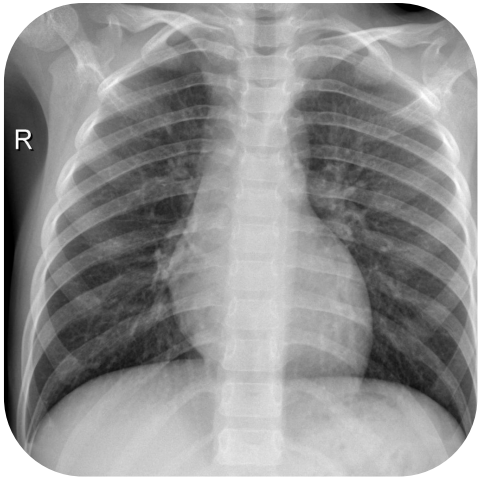
Framework

- Noise analysis and modeling
- Coder comparison using perceptual metrics
- QS selection strategy
- Clinical verification



Our Work

- Implement article's compression
- Reproduce experiments
- Test on chest X-rays

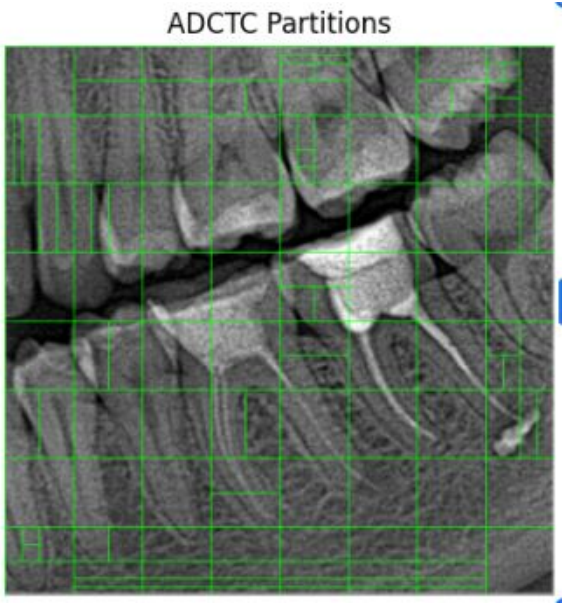


Method

Methodology

- This work applies the ADCT algorithm to compress images
- Because ADCT adapts compression to image content, it provides better fidelity than non-adaptive methods such as JPEG2000
- This work aims to select the optimal input hyperparameter for the ADCT algorithm

ADCT Algorithm

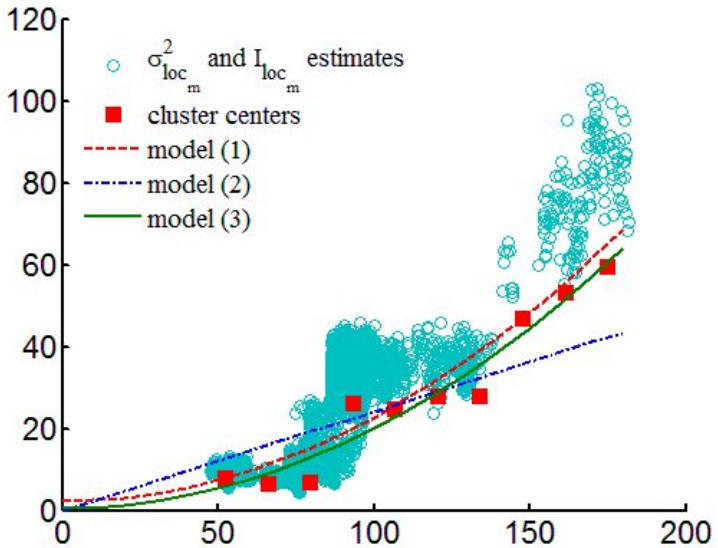


- based on DCT with adaptive partitioning
- driven by Quantization Step (QS) as a key input parameter
- context-based statistical modeling and arithmetic coding of DCT data
- choosing QS balances compression ratio and diagnostic quality

Analysis of Noise Properties in Dental Images

- Noise variance is estimated as a combination of additive, multiplicative, and Poisson-like components

$$\hat{\sigma}_{eq}{}^2 = \hat{\sigma}_a{}^2 + \hat{\sigma}_\mu{}^2 I^2 + kI$$

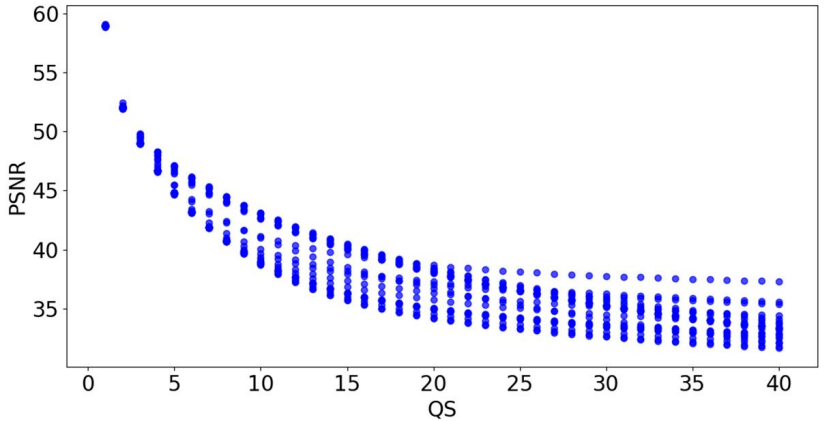


Invisibility Condition of Compression Noise in Images

- For compression distortion to be invisible, it must be much smaller than the image noise

$$\sigma_{distortion}{}^2 \leq \frac{\sigma_{noise}{}^2}{10} \qquad (1)$$

$$PSNR = 10 \log_{10}\left(\frac{MAX^2}{MSE^2}\right) \qquad (2)$$



Methodology Overview

Goal: Efficient compression of dental images with high diagnostic quality

Idea: Select the optimal Quantization Step (QS) based on image noise

Workflow:

1. Noise analysis of input image
2. Define target PSNR from noise level
3. Apply ADCT with optimal QS
4. Evaluate quality with metrics

Result

Experiments

- **Datasets:** panoramic dental images and chest images in two resolutions
- **Metrics:** FSIM, PSNR HVS M
- **Experiments:**
  - Validate paper results on a new dental dataset
  - Find QS for chest X-ray Images
  - Analyze QS in higher resolution

Table1. Datasets Details

Type	Imaging	Number Of Images
Panoramic Dental [1]	X-Ray 512	48
Chest [2]	X-Ray 512	145
Chest [2]	X-Ray 1024	107

ADCT vs JPEG2000

- Encode and decode Images with different QS values
- Encoding using jpeg2000
- Significant improvement compared to jpeg2000

Fig1. Sample of panoramic dental image

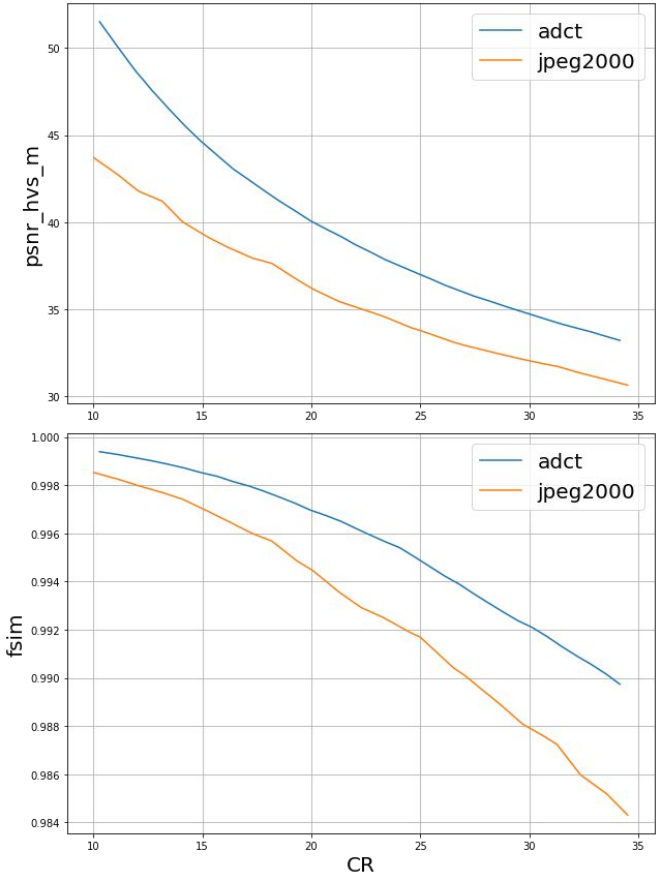


Fig2. adct and jpeg2000 quality on dental image

Find QS

- Encode and decode images for QS in the range (6, 42)
- Find QS values where
  - FSIM > 0.99
  - Psnr hvsm > 40db
- Charts
  - Red line shows the threshold
  - Blue line indicates the best QS for each metric
- QS=16 works well for all sample images

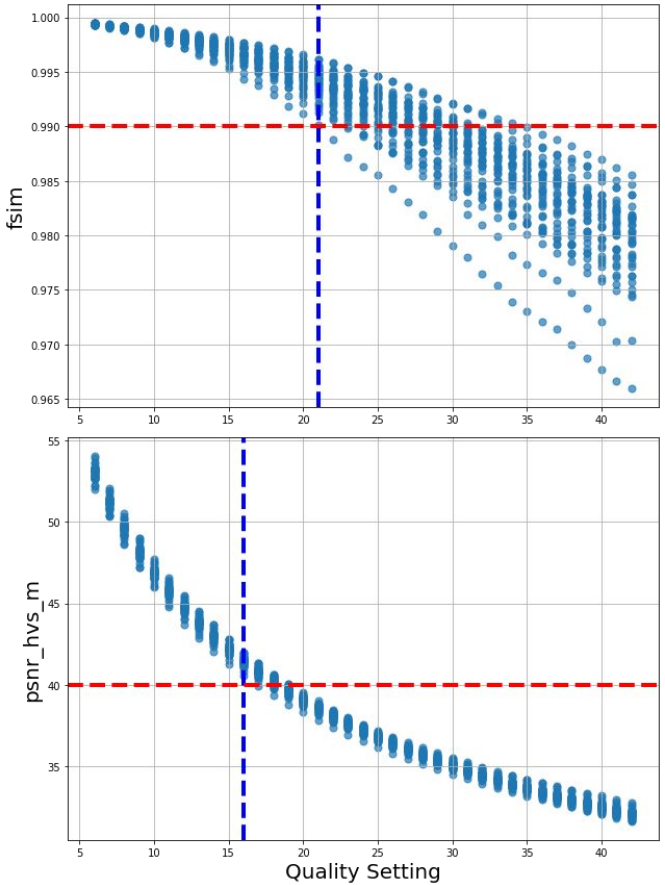


Fig3. Adct on panoramic dental dataset

Best QS for Chest X-ray 512

- QS = 14 performs well in psnr-hvs-m
- QS = 6 performs well in fsim
- The average CR is around 10
- Results are not always normal

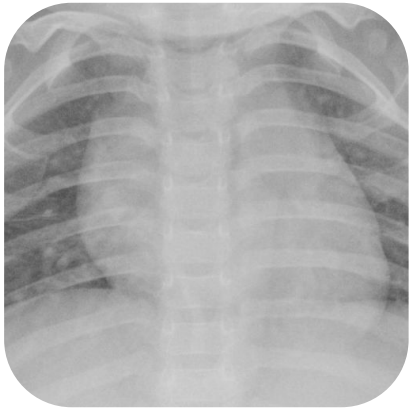


Fig4. image with low fsim

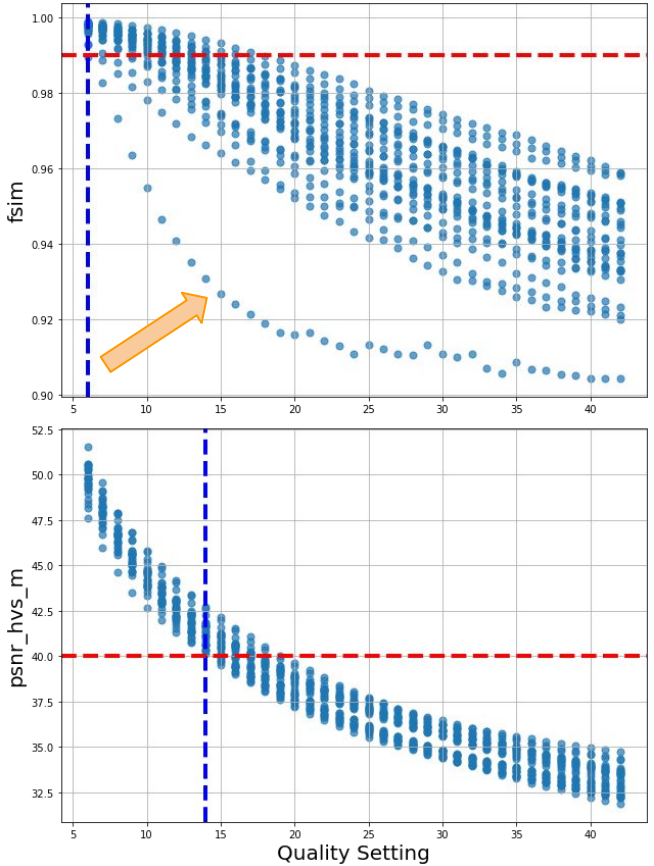


Fig5. Adct on chest X-ray 512 dataset

Best QS for Chest X-ray 1024

- QS = 12 also performs well in psnr-hvs-m
- QS = 6 does not perform well in fsim
- A single good QS value could not be found for all scenarios

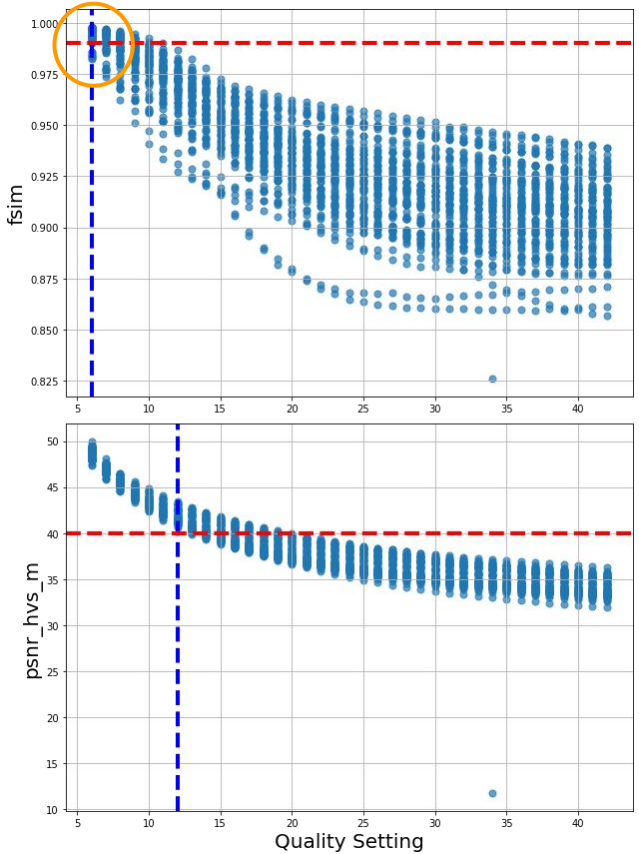


Fig6. Adct on chest X-ray 1024 dataset

Clinical Verification

- Chest X-ray 512 compress with QS=6
- Image shuffling and doctor evaluation
- Better in Ideal images

Table2. results of doctor evaluation

Compression Status	Total Images	Unusable %	Weak %	Sufficient %	Ideal %
Compressed	27	**0**	22	33	**45**
Uncompressed	23	4	22	**35**	39

Conclusion

- **Introduction**: Main paper overview
- **Method**: Relation between noise and qs , Explain Adct
- **Results**: Check paper results and Find QS for chest images

Any Question?

References

1. Mooney, P. (2018). Chest X-Ray Images (Pneumonia) [Data set]. Kaggle. Retrieved August 19, 2025, from https://www.kaggle.com/datasets/paultimothymooney/chest-xray-pneumonia

2. Vipul Arya, K. (n.d.). A Collection of Dental X-Ray Images for Analysis [Data set]. Kaggle. Retrieved August 19, 2025, from https://www.kaggle.com/datasets/kvipularya/a-collection-of-dental-x-ray-images-for-analysis

3. Krivenko, S., Lukin, V., Krylova, O., Kryvenko, L., & Egiazarian, K. (2021). A Fast Method of Visually Lossless Compression of Dental Images. *Applied Sciences*, 11(1), Article 135. https://doi.org/10.3390/app11010135

4. Abramova, V., Krivenko, S., Lukin, V., & Krylova, O. (2020). Analysis of noise properties in dental images. In *2020 IEEE 40th International Conference on Electronics and Nanotechnology (ELNANO)* (pp. 511–515). IEEE. https://doi.org/10.1109/ELNANO50318.2020.9088819

5. Ponomarenko, N., Lukin, V., Egiazarian, K., & Astola, J. (2008). ADCTC: Advanced DCT-Based Image Coder. In *Proceedings of the 2008 International Workshop on Local and Non-Local Approximation in Image Processing (LNLA 2008)* (pp. 511–515). IEEE. https://doi.org/10.1109/ELNANO50318.2008.4522211

AppendiX

Datasets

Table1. Datasets Details

Type	Imaging	Resolution	Number Of Images	Sample
Panoramic Dental	X-Ray	512 * 512	48	35
Chest	X-Ray	512 * 512	145	26
Chest	X-Ray	1024 * 1024	107	70