# Volume Rendering Using Principal Component Analysis

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Principal Component Analysis

Principal Component Analysis:

- Find a set of orthogonal bases (eigenvectors) that best describe the variability in the input samples.
- These eigenvectors are ordered based on the variability covered by each individual eigenvector (defined by its eigenvalue).
- In our case the input samples are pre-rendered images using standard raycaster from a spherically distributed camera positions.
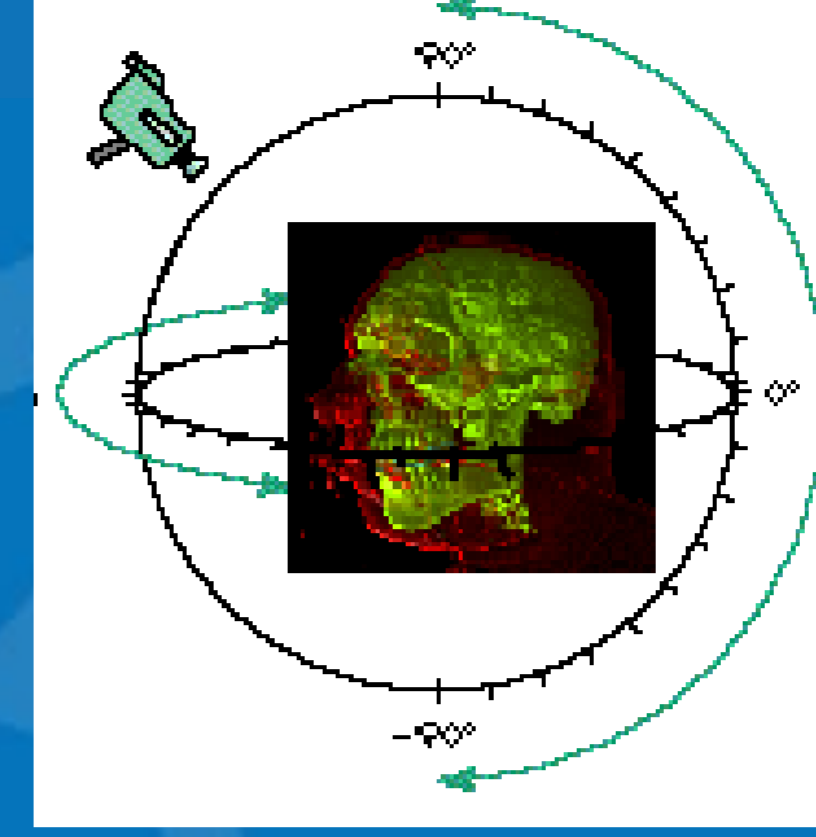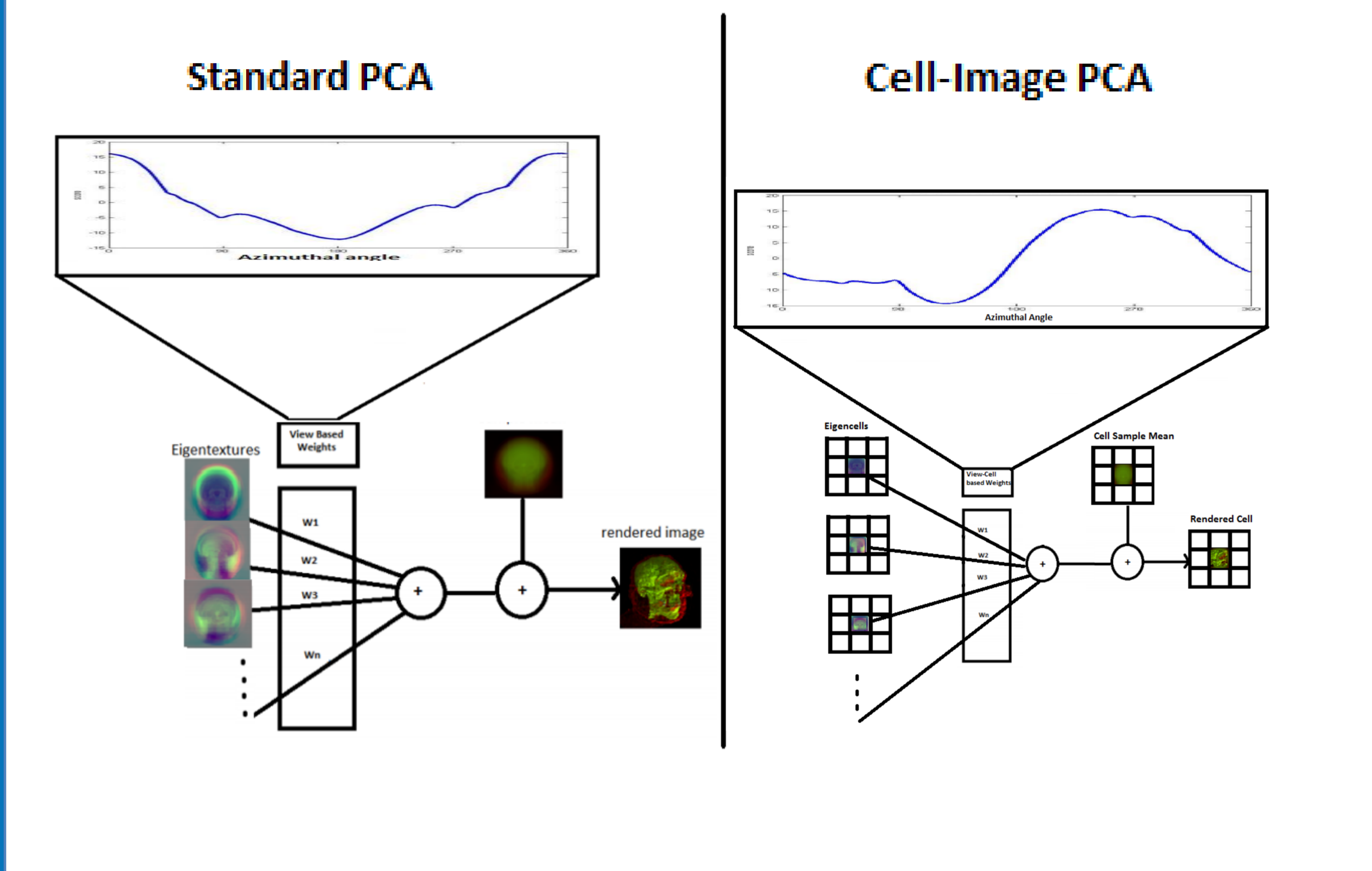
$$C = \frac{1}{n-1} X X^T = \frac{1}{n-1} \sum_{i=1}^{n} x_i x_i^T$$
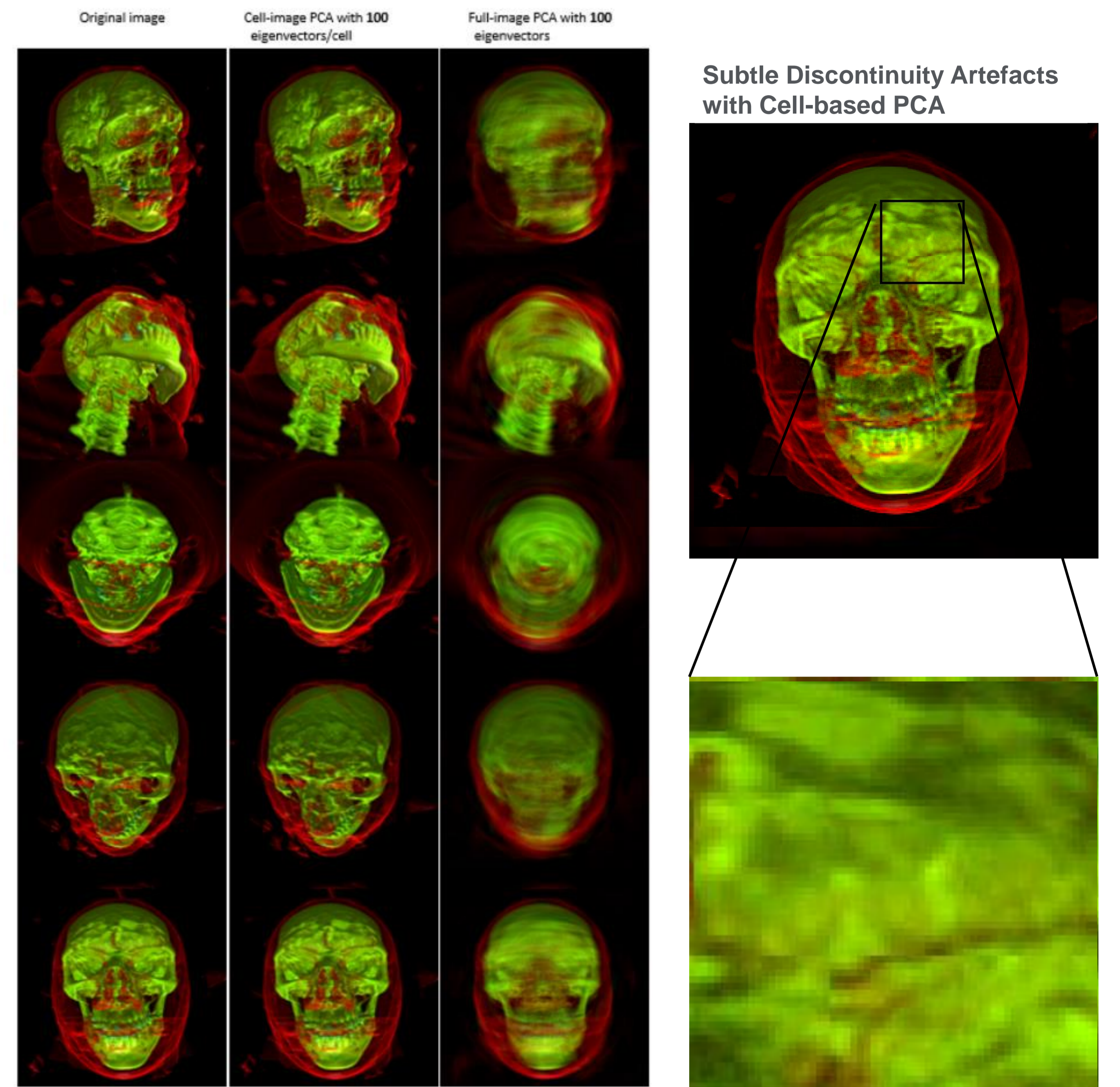
$$(C - \lambda I) v = 0; \quad v^T v = 1$$

Standard PCA VS. Cell-Image PCA

PCA for Volume Rendering

Standard PCA   Cell-Image PCA

- We applied PCA to RGB images with resolution of 300x300 pixels.
- In cell-image PCA the images are divided into equally sized cells and then apply PCA to each cell region individually.
- We applied cell-image PCA for cell size of 20x20 RGB pixels.
- We used 100 eigenvectors per cell to encode the computed eigenspace.
- We then synthesize a novel view image by interpolating the scores in the eigenspace.

Results

Original image | Cell-image PCA with 100 eigenvectors/cell | Full-image PCA with 100 eigenvectors

Subtle Discontinuity Artefacts with Cell-based PCA

Findings

1. The cell-image PCA approach leads to much better quality results compared to the standard PCA.
2. The standard PCA results in somewhat blurry images for the same distribution of training samples.
3. One problem with cell-based PCA is that it results in subtle discontinuity artefacts at the cell boundaries in the reconstructed images.
4. Another problem with PCA based approaches is that a change in the transfer function requires a change in the computed eigenspace.

Future Goals

- Conduct perceptual studies to measure the conspicuity of artefacts in both PCA approaches under different viewing and training configurations and across different scales and types of data sets.
- Investigate strategies to ameliorate the subtle artefacts appearing in the cell boundaries.

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