Modeling X-ray and Natural Images: Perceptually Relevant Image Statistics and Applications

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To improve artificial vision systems, human vision should be better understood. Many aspects of human vision are tuned to the characteristics of its natural inputs. These characteristics include global statistics (power spectrum) and local statistics (multipoint correlations). The origin of the distinctive pattern of image statistics is not fully understood. Medical radiographs or x-ray images and natural images have properties that are crucial to machine and human vision and their analysis has important applications. To address the origin of the statistical properties of these image classes, a series of generative models was built, taking into account relevant qualities: dimensionality, occlusion, and object size distribution. Then global and local image statistics were calculated for each model. The power spectra depicted differences between image models and were consistent with real natural and x-ray images. For local image statistics, the models accounted for the prominence of pairwise statistics and some three and four point statistics found in real x-ray images. Occlusion vs. transparency and size distribution had a large effect on the mean values of multipoint correlations, while they had a smaller effect on their standard deviations. Overall, generative models can explain some crucial characteristics of natural and x-ray images. The 3D x-ray model is the first time a model has been created to mimic the properties of medical images. This model has significant applications to denoising x-ray images by training with synthetic images: global statistics of real noisy x-ray images and noisy model images have promising similarities.

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