NATURAL IMAGE STATISTICS AS A FUNCTION OF DYNAMIC RANGE

Antoine Grimaldi, David Kane & Marcelo Bertalmío

Introduction

The human visual system (HVS) has evolved to cope with the natural world. Understanding the statistical regularities in the world can help us understanding the HVS and aid the design of image processing algorithms.

- Spatial local correlation in natural images (Huanc & Mumford, 1999) are used for JPEG compression.
- Statistical properties of natural images belonging to different categories are relevant for scene and object categorization tasks. (Torralba & Oliva, 2003)
- The average power spectrum of an image follows a power law (Field, 1987) which means image properties are scale invariant.
- Simple-cell receptive field properties have emerged by learning a sparse code for natural images. (Olshausen & Field, 1996)

High Dynamic Range (HDR) images can provide more information (DR = \text{max} / \text{min}).

- Nearly all studies have used image databases captured using single-exposure photography, the dynamic range of a single exposure is 1000:1.
- Multi-exposure photography can capture a greater dynamic range of any scene.

Results

Histograms

Power Spectra

Discussion

- Statistics of the images seem to change as a function of the DR, both histograms and power spectra seem affected by the DR.
- Scale invariance begins to fail at high dynamic range images.
- It may be only due to the presence of intense light sources.
- After applying the Naka-Rushton equation to model the nonlinearity of the photoreceptors' response the 1/f statistic is recovered.
- At the retinal image, i.e. after applying Naka-Rushton equation, the statistical moments of the intensity distributions lose their effect.
- The image dataset comes from equirectangular projections of the Southampton-York Natural Scenes 3D images and they present some artifacts. However, these artifacts don't seem to affect the statistics used here.

Future Work

- Creation of an HDR natural images dataset with better control over the possible effect of the DR.
- Creation of a synthetic HDR dataset created using a physically accurate rendering model.

References


Examples of power spectra fitted with a first order and a second order polynomial.