

Statistical Invariances in Artificial, Natural, and Urban Images

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To answer the question about the way our visual system processes images it has to work with every day, it is necessary to investigate the statistical structure of these pictures. For this purpose we investigated several ensembles of artificial and real-world greyscale images to find different invariance properties: translation invariance by determining an average pair-correlation function, scale invariance by investigating the power spectrum and the coarse graining of the images, and a new hierarchical invariance recently proposed [D. L. Ruderman, *Network* **5**, 517 (1994)]. The results of our work indicated that the assumption of translational invariance can be taken for granted. Our results concerning the scale invariance are qualitatively the same as those found by Ruderman and others. The deviations of the distributions of the logarithmically transformed images from a Gaussian distribution cannot be seen as clearly as stated by Ruderman. This results from the fact that for a correct determination of the deviations the non-linear transformation must be considered. Depending on the preprocessing of the images the results concerning the hierarchical invariance differed widely. It seems that this new invariance can be confirmed only for logarithmically transformed images.

Key words: Natural Images; Urban Images; Image Statistics; Invariance Properties of Images; Image Preprocessing.

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