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Image Quality Assessment of Computer-generated Images

Based on Machine Learning and Soft Computing

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Preface

The measure of image (videos) quality remains a research challenge and a very active field of investigation considering image processing. One solution consists of providing a subjective score to the image quality (according to a reference or without reference) obtained from human observers. The setting of such psycho-visual tests is very expensive (considering time and human organization) and needs clear and strict proceedings. Algorithmic solutions have been developed (objective scores) to avoid such tests. Some of these techniques are based on the modeling of the Human Visual System (HVS) to mimic the human behavior, but they are complex. In the case of natural scenes, a great number of image (or video) quality databases exist that makes possible the validation of these different techniques. Soft computing (machine learning, fuzzy logic, etc.), widely used in many scientific fields such as biology, medicine, management sciences, financial sciences, plant control, etc., is also a very useful cross-disciplinary tool in image processing. These tools have been used to establish image quality and they are now well known.

Emerging topics these last years concern **image synthesis**, applied in virtual reality, augmented reality, movie production, interactive video games, etc. For example, unbiased global illumination methods based on stochastic techniques can provide photo-realistic images in which content is indistinguishable from real photography. But there is a price: these images are prone to noise that can only be reduced by increasing the number of computed samples of the involved methods and consequently increasing their computation time. The problem of finding the number of samples that are required in order to ensure that most of the observers cannot perceive any noise is still open since the ideal image is unknown.

Image Quality Assessment (IQA) is well known considering natural scene images. Image quality (or noise evaluation) of computer-generated images is slightly different, since image generation is different and databases are not yet developed. In this short book, we address this problem by focusing on **visual perception of noise**. But rather than use known perceptual models, we investigate the use of **soft computing approaches** classically used in the Artificial Intelligence (AI) areas such as full-reference and reduced-reference metrics. We propose to use

such approaches to create a machine learning model based on learning machines such as SVMs and RVMs in order to be able to predict which image highlights perceptual noise. We also investigate the use of **interval-valued fuzzy sets** as no-reference metric. Learning is performed through the use of an example database which is built from experiments of noise perception with human users. These models can then be used in any progressive stochastic global illumination method in order to find the visual convergence threshold of different parts of any image.

The short book is organized as follows: after a brief introduction (Chap. 1), Chap. 2 describes the Monte Carlo methods for image synthesis we use, and then chapter briefly describes the visual impact of rendering on image quality and the interest of a noise model. In Chap. 4, image quality evaluation using SVMs and RVMs is introduced and in Chap. 5 new learning algorithms that can be applied with interesting results are presented. Chapter 6 introduces an original method obtained from the application of fuzzy sets entropy. Finally, the short book is summarized with some conclusions in Chap. 7.

The goal of this book is to present an emerging topic, that is to say IQA for computer-generated images, to students (and others) practitioners of image processing and related areas such as computer graphics and visualization. In addition, students and practitioners should be familiar with the underlying techniques that make this possible (basics of image processing, machine learning, fuzzy sets). This monograph will be interesting for all people involved in image generation, virtual reality, augmented reality, and all new trends emerging around these topics.

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