Synthesis Lectures on Visual Computing:
Computer Graphics, Animation, Computational Photography and Imaging

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Shiguang Liu

Image and Video Color Editing

Springer

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This series presents lectures on research and development in visual computing for an audience of professional developers, researchers, and advanced students. Topics of interest include computational photography, animation, visualization, special effects, game design, image techniques, computational geometry, modeling, rendering, and others of interest to the visual computing system developer or researcher.

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Preface

Digital image processing is generally processed by computer, so it is also called computer image processing. The purpose of early image processing is to improve the quality of an image so as to produce a better visual perception for the viewer. General image processing methods include image enhancement, restoration, coding, compression, etc. The first successful practical application was the Jet Propulsion Laboratory (JPL). They used image processing techniques such as geometric correction, gray scale transformation, noise removal and other methods to process thousands of lunar photos sent back by the space probe "Wanderer 7" in 1964, and successfully reconstructed the lunar surface by further considering the influence of the sun's position and the lunar environment. In the future aerospace technology, such as the exploration of Mars, Saturn and other planets, digital image processing technology has also played a critical role. Another great achievement of digital image processing is medicine. For example, CT (Computer Tomography) and non-invasive diagnostic technology have made epoch-making contributions to mankind. Video is a sequence of time varying images. Video processing is an extension of image processing, with an emphasis on both spatial and time coherence.

With the rapid development of digital image and video processing techniques, they have become the object of research among various disciplines in the fields of engineering, computer science, information science, statistics, physics, chemistry, biology, medicine and even social science. Nowadays, image and video processing technology has brought great economic and social benefits to mankind. In the near future, it will not only have more in-depth development in theory, but also be an indispensable and powerful tool in scientific research, social production and even human life in application.

One of the most common image and video processing methods is to change the color of an image (or video) to meet the user's demand. So far, there are many ways to change the color of an image (or video), including color transfer, colorization, decolorization, style transfer, enhancement, etc.

Image and video color transfer: Color transfer is one of the widely used color editing methods. It is a statistics-based technique. Its main idea is to transfer the color characteristics of a target image to another source image or video, so that the source image has the same color distribution as the target image. These methods focus on processing the

color of an image or video to achieve some visual effect, ignoring the emotion an image or video conveys. To this end, some researchers developed emotional color transfer to transfer both the color and emotion of a target image to a source image (or video).

Image and video colorization: Colorization aims to adding colors to a grayscale image or video. This task is ill-posed in the sense that assigning the colors to a grayscale image without any prior knowledge is ambiguous. Most of the previous methods require some amount of user interventions to assist the coloring process. Moreover, video colorization technology is more difficult, since it also needs to keep the time-space consistency of the results. At present, there are a large number of grayscale or black and white images and video materials in various fields such as film and television, picture archives, medical treatment, etc. Coloring them can enhance the details and help people better identify and make better use of them.

Image and video decolorization: Decolorization refers to convert a color image or video into a grayscale one. This transformation process is a dimension reduction process, i.e., from a cubic matrix to a single matrix. In this process, information loss will inevitably occur. The key of decolorization is to make the decolorization results retain human's perception of the original color image or video as much as possible. It is widely used in daily life. For example, most newspapers choose to use grayscale images as illustrations to save expenses; on the other hand, grayscale images have become a favorite artistic choice for photographers around the world; in addition, grayscale images and videos are also widely used in medical imaging and surveillance.

Image and video style transfer: Given a source image or video and a style image, style transfer is to make the source image or video show the "style" of the style image. It can make an image or video display a variety of stylized effects, giving one more appealing visual appreciation. For example, it can convert a photo taken by yourself into an image with the artistic style of Monet, Van Gogh and other painting giants. Style transfer is closely related to texture synthesis. Texture synthesis attempts to capture the statistical relationship between pixels in the source image, while style transfer also preserves the content structure.

Image and video enhancement: Photography devices may capture images or videos with poor quality under a low light-level photographic environment. Due to the low visibility, these underexposed images and videos usually fail to present visually pleasing browsing. Image and video enhancement aim to reveal hidden details in underexposed videos and improve video quality, which can benefit the downstream image and video processing tasks. Image and video color enhancement technology has a wide range of applications, including target fusion, target tracking, video compression, etc. Enhancement of a low exposure video can also improve the appearance of surveillance video shot by a monitoring system under bad weather.

Most of these research results were published at leading venues in computer graphics, computer vision, image processing, multimedia, etc. This stimulated further research and helped establish a large research and development community. This monograph gives an overview of image and video color editing methods, with specific emphasis on fast techniques developed over the last 20 years.

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