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**Texture Synthesis**

In image processing, texture is a concept that is hard to grasp and its definitions can vary depending on the use case or application field. Consequently, it is logical that texture synthesis is a complex topic too. Many methods of synthesis exist and are each one adapted to different uses. Many fields can use it, such as computer graphics [1][2], ultrasound synthesis in medical imaging, which can help train doctors with US diagnostics[3], information embedding for copyright protection or hiding data [4]. Even design and art, for example to replicate a known artist style [15].

First, we can quickly go over the used indicators and descriptors that are used to compare textures and to determine the performance quality of a synthesis method, using the review in [5]. We have local descriptors that can help describe and compare structures around a certain neighbourhood in textures. Some examples are SIFT, HOG or local binary patterns and its variations (Local Ternary Patterns, Local Configuration Patterns, or Multi-Scale LBPs wich have proven to describe bigger and separate neighbourhoods more efficiently [6]). Then we have global descriptors wich are more useful in detecting periodicities and global features in textures. Examples of these are GIST descriptors or Co-occurrence matrices [7].

There exists traditional texture synthesis methods as well as Deep Learning methods. In article [8] and we have a survey on the state of the art from which we took examples. An example of traditional method is the Efros-Leung non-parametric method [9]. It generates the texture from an initial seed using a Random Markov field hypothesis to grow outwards, this method is limited to the generation of images with similar or similarly illuminated texels and is pixel-based. We also have patch-based methods such as Image Quilting, which uses a replication/paving approach and is not adapted to micro-textures or textures that do not have a specific periodicity, such as ultrasounds [10]. Another patch-based approache is [11], this method is better at preserving structural patterns than [9] and better at blending the patches seamlessly than [10]. There are also feature matching techniques which seamlessly merge patches [12]. A more complete method mixes local orientation analysis, grouplet decomposition and statistical modeling of structures to efficiently synthezise nature-like textures [13]. Newer Deep Learning methods can overcome the limitations of the mentioned methods. With the rapid progress in the field, we have an increasing variety of works in this category. For instance, the work in [14] uses a Markovian GAN network to generate textures using patches of variable size described by statistical features. Moreover, convolutional networks used for classification are useful too. The VGG-19 network is used in [15] to generate a new image from a style image and a content image, new textures can be replicated by inputting the base texture as style and white noise as content. VGG-19 is also used in [16]. Both use cases show that discriminative networks are efficient in a generative task thanks to their perceptual quality; there is high statistic similarities between natural images and generated images.

Despite having better performances, the issue of Deep Learning remains the computing time, this problem is adressed in [14]. Thanks to GPUs and optimization methods, Said methods remain accessible.

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