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Towards Exploiting Change Blindness for Image Processing

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Abstract

Change blindness is a type of visual masking which affects our ability to notice changes introduced in visual stimuli (e.g. change in the colour or position of an object). In this paper, we propose to use it as a means to identify image attributes that are less important than others. We propose a model of visual awareness based on low-level saliency detection and image inpainting, which identifies textured regions within images that are the most prone to change blindness. Results from a user study demonstrate that our model can generate alternative versions of natural scenes which, while noticeably different, have the same visual quality as the original. We show an example of practical application in image compression.

Keywords: Perception, Visual Awareness, Visual Attention, Change Blindness, Salience, Image Quality

1. Introduction

With the number of digital pictures taken every year running into the trillions [1], it has become increasingly important to understand how people perceive image contents in order to manipulate them more efficiently. Indeed, our visual system filters out visual information in a variety of ways and a wide range of image processing applications such as compression, watermarking or cross-media reproduction rely on identifying what we can and cannot see within images. For instance, very high frequency components can be removed without disturbance in typical viewing conditions due to limited contrast sensitivity, which is useful for data reduction [2]. Other early vision[1] mechanisms such as low-level texture masking [4], salience [5, 6, 7] or chromatic adaptation [8] have also been used to predict subjective image quality assessments and improve image processing techniques. On the other hand, higher levels of perception and cognition (late vision) are also subject to a number of flaws which can affect our perceptual experience and interpretation of image quality [9, 10]. While limits in our early vision renders image attributes invisible, even if we know where they are, late vision flaws pertain more to the perceived importance of these attributes. In the case of images (as opposed to videos) the distinction between *invisible* and *unimportant* is crucial in that it involves time: if a distortion cannot be detected rapidly, it can arguably be considered as acceptable. In this study, we test this hypothesis in the particular case of natural images containing large and complex textured regions. Unlike prior work on exploiting perceptual failures for prediction of image quality, we propose to identify the *important* information in images via a relatively unknown high-level mechanism of the human visual system (HVS): *visual awareness*.

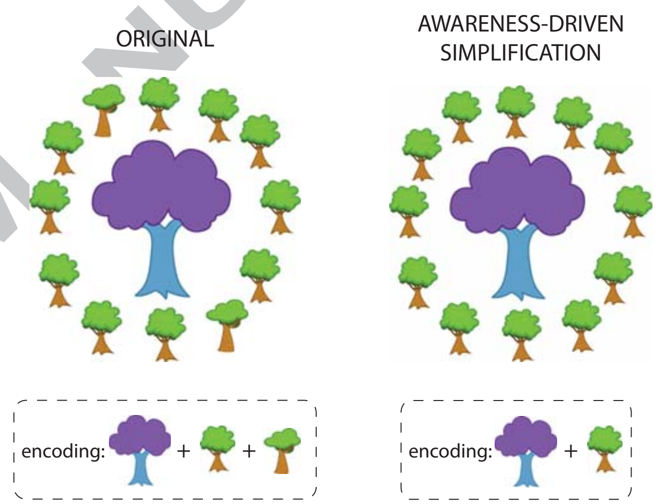

Figure 1: Principle of awareness-driven image simplification: make observers unaware that the background has been simplified by exploiting change blindness. Notice that on the left image, there are two different kinds of green/brown trees, whereas on the right, there is only one kind. As a result, the amount of data needed to encode the latter image is smaller.

Figure 2 depicts an example of the game "Spot the difference". We found that it takes most people at least 45 seconds to notice the missing engine under the wing. This comes from a remarkable shortcoming of our visual system referred to as *change blindness* [12, 13]. While the origins and implications of this phenomenon are not yet fully understood, it is known to come from a failure to accurately represent and compare visual stimuli in memory [14]. Changes affecting the gist of the scene are detected faster [15, 16], yet the nature and context of the change can make it very difficult to see, even in the most salient image regions [17, 18], as in Figure 2. Change blindness

[1] Typically, *early vision* refers to the first steps of visual perception where basic features like motion, colour and binocular disparity are measured [3].