Title:

White balance in the presence of mixed colour illuminations

Supervisors:

C. Alejandro Parraga (http://www.cvc.uab.es/~aparraga/)

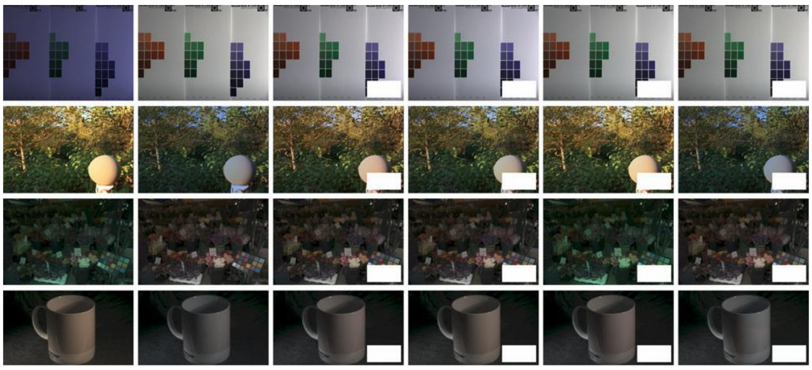
Summary:

White balance (WB) algorithms compensate for the colours of illuminants. For example, tungsten lights introduce a yellowish cast. Unfortunately, many scenes exhibit a combination of illuminants (e.g., artificially lit indoor scenes plus light from a window). In these cases, WB is a challenging task. Our aim is to extend the capabilities of existing WB algorithms to mixed coloured illuminants.

Extended abstract:

WB algorithms are practical implementations of an intrinsic ability of our brains. To our brain the colour of an object appears largely the same throughout the day, despite dramatic changes in the spectral composition of the light reflected from a scene (e.g., the gamut of physical colours at sunset almost doubles in comparison to the "flattish" midday illumination). This ability (called "colour constancy"), is more impressive if we consider that mathematically, the problem of separating illumination form reflectance is ill-posed, i.e., there are infinite possible solutions. There are many algorithms that try to imitate this feature of our brain however, up to now, none is capable to replicate it 100% [1-3].

Background: The exact mechanism of human colour constancy is not understood [4]. From a mathematical point of view, retrieving the colour of a surface illuminated by light of unknown spectral distribution is underdetermined, and to computationally rectify biased images (in the same way colour constancy does) it is common to impose several assumptions regarding the scene illuminant, the statistical distribution of colours or edges, etc. There are several types of colour constancy algorithms, which can be classified into *Learning-based*, *Physics-based*, *Biologically-based*, and *learning-free* depending on their original premises (see figure results). In humans, colour constancy operates in three levels:



1) Sensory level: modelled by simple linear transformations of the photoreceptor responses, e.g., scaling responses by their mean activities over the image.

2) Perceptual level: modelled considering various perceptual "cues" such as specular highlights, mutual reflections, achromaticity of edges, etc. segmenting the image into distinct components (reflections, edges and surfaces) to estimate the illuminant.

3) Cognitive level: modelled considering colour memory and/or the identification of objects to be able to compensate for the effects introduced by familiar objects.

The relative contributions of each of these processing levels is still a matter for debate. However, most researchers acknowledge that cognitive contributions are likely to be small since the phenomenon can be largely explained by low level mechanisms present in the retina and some areas of the visual cortex.

Little is known about how the brain implements colour constancy in the presence of multiple mixed-colour illuminations.

To do: Our approach will start with the standard workflow used for automatic single light white balance, but then will move to address the more challenging problem of mixed white balance. We will explore both, manual (the user adjusts the image to get an approximate result) and automatic approaches. We will make use of standard psychophysical techniques to obtain and evaluate observer's results and we will use state of the art algorithms to implement automatic solutions.

References:

1. B. Gao, K.-F. Yang, C.-Y. Li, and Y.-J. Li. Color constancy using double-opponency. TPAMI, 37(10):1973–1985, 2015.
2. Akbarinia and C. A. Parraga. Colour constancy beyond the classical receptive field. TPAMI, 2017
3. Qian Y, Kamarainen JK, Nikkanen J, Matas J. On Finding Gray Pixels. CVPR2019
4. Foster DH (2011) Color Constancy. Vis. Res. Volume 51: 674-700.
5. Boyadzhiev et al AM Trans Graph 31(6)2012