Abstract

To capture colour images, three primary colours at each pixel have to be acquired. To reduce size and cost, a single image sensor is normally used with a Colour Filter Array (CFA) which covers this single sensor to measure only one of the three primary colours at each pixel location. The CFA image is then used to produce a full-colour image by an interpolation process, known as CFA demosaicking, to estimate the two missing colour components of each pixel. However, some image processing algorithms, including demosaicking, produce colour artefacts in the output images, and a post-processing method that removes those colour artefacts is desired. To assess the performance of processing algorithms, Image Quality Assessment (IQA) tools are used to measure the accuracy of the output colour images.

In this thesis, the first aim is to develop a demosaicking algorithm with high colour accuracy for newly acquired images. The second aim is to detect and remove colour artefacts in already demosaicked or processed images, and the third aim is to develop an IQA method to quantify visible colour artefacts in processed images.

We develop a novel demosaicking technique that simultaneously demosaics the three colour planes as a solution to problems with existing demosaicking techniques that demosaic the three colour planes sequentially, which unknowingly produces colour artefacts until the demosaicking process is completed. As a consequence of our simultaneous interpolation of three colour planes, visible colour artefact pixels can be identified and avoided from selection during the demosaicking process. Our proposed simultaneous demosaicking method can produce high colour accuracy in the output demosaicked images compared with other sequential demosaicking methods. Several RGB colour values will be simultaneously created for each pixel location, and an optimal RGB colour value will be selected based on the colour-line property. It has been shown that our novel demosaicking method outperforms other benchmarking methods by producing highly accurate demosaicked images with minimal visible colour artefacts.

Since image processing algorithms, such as demosaicking and denoising, will produce visible colour artefacts in the output images, it is desirable to have a post-processing technique that removes those colour artefacts from the processed images. However, most existing post-processing techniques such as image denoising, are unable to effectively filter out colour artefacts since colour artefacts do not

exhibit common noise characteristics and are more feature dependent, localized and non-randomly distributed. To achieve the second aim of this thesis, a novel blind colour artefact detection technique is developed to detect colour artefacts without the original image to reference as the ground truth, which is not available in practice. Incorporating our blind detection technique, we developed a novel technique to correct colour artefacts by re-mapping their colours based on the neighbouring true colour pixels in order to blend them with the neighbouring colour pixels. It has been shown that the proposed methods can improve the visual quality of the processed images.

As the majority of Image Quality Assessment (IQA) methods measure the overall image quality including all visible and non-visible errors, they often do not correlate well with visual assessment since only visible errors are the main contributing factor. In order to meet our third aim, a novel IQA method is developed to quantify visible colour artefacts alone in a processed image. It has been shown that our proposed IQA method correlates well with visual perception of colour artefacts and is virtually independent of other errors, such as errors due to image blurring.

All in all, the main original contributions to knowledge made in this thesis include: (a) a novel proposed simultaneous demosaicking method that can produce high quality and colour accurate demosaicked images that preserves sharp edges and fine details; (b) a novel blind colour artefact detection without ground truth; (c) a novel method for the removal of colour artefacts, that incorporates our blind detection method, to improve the visual quality of images, and (d) a novel image quality assessment method that can quantify only visible colour artefacts.