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A Novel Approach to Access the Quality of Tone Mapped Images

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ABSTRACT: This paper deals with the assessment of measuring the quality of tone mapped images by considering the Tone Mapping Operators (TMOs) that convert high dynamic range (HDR) to low dynamic range (LDR) images provide practically useful tools for the visualization of HDR images on standard LDR displays. Different TMOs create different tone mapped images, and a natural question is which one has the best quality. Without an appropriate quality measure, different TMOs cannot be compared, and further improvement is directionless. Subjective rating may be a reliable evaluation method, but it is expensive and time consuming, and more importantly, is difficult to be embedded into optimization frameworks. Here we propose an objective quality assessment algorithm for tone mapped images by combining two concepts one of them is a multi scale signal fidelity measure on the basis of a modified structural similarity index and the other followed by a naturalness measure on the basis of intensity statistics of natural images. Validations using independent subject-rated image databases show good correlations between subjective ranking score and the proposed tone-mapped image quality index (TMQI). The proposed measure not only provides an overall quality score of an image, but also creates multi-scale quality maps that reflect the structural fidelity variations across scale and space**.**

KEYWORDS: Tone Mapping Operators, low dynamic range, high dynamic range image, image fusion, image quality assessment, naturalness, perceptual image processing, structural similarity, tone mapping operator.

I. INTRODUCTION

There has been a growing interest in recent years in high dynamic range (HDR) images, where the range of intensity levels could be on the order of 10,000 to 1. This allows for accurate representations of the luminance variations in real scenes, ranging from direct sunlight to faint starlight [1]. With recent advances in imaging and computer graphics technologies, HDR images are becoming more widely available. A common problem that is often encountered in practice is how to visualize HDR images on standard display devices that are designed to display low dynamic range (LDR) images. To overcome this problem, an increasing number of tone mapping operators (TMOs) that convert HDR to LDR images have been developed, for examples [2]–[5]. Because of the reduction in dynamic range, tone mapping procedures inevitably cause information loss. With multiple TMOs available, one would ask which TMO faithfully preserves the structural information in the original HDR images, and which TMO produces natural-looking realistic LDR images. TMO assessment in the past mostly relied on human subjective evaluations. In [6], perceptual evaluations of 6 TMOs were conducted with regard to similarity and preferences An overview and a subjective comparison of 8 TMOs were reported in [7]. HDR capable monitor was employed in to compare 6 TMOs in a subjective experiment using a paired comparison method. In, 14 subjects were asked to rate 2 architectural interior scenes produced by 7 TMOs based on basic image attributes as well as the naturalness of the LDR images. A more comprehensive subjective evaluation was carried out in where tone mapped images generated by 14 TMOs were shown to 2 groups of 10 human observers to rate LDR images, concerning overall quality, brightness, contrast, detail reproduction and color. In subjects were asked to choose the best LDRs derived from 2 TMOs with different parameter settings to optimally tune the algorithms. The value of subjective testing cannot be overestimated. However, they have

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fundamental limitations. First, it is expensive and time consuming. Second, it is difficult to be incorporated into an optimization framework to automatically improve TMOs and adjust their parameter settings. Furthermore, important image structures contained in HDR images may be missing in tone mapped images, but human observers may not be aware of their existence. In this sense, subjective evaluation should not be regarded as a golden standard for the quality of tone mapped images. Typical objective image quality assessment (IQA) approaches assume the reference and test images to have the same dynamic range [12], and thus cannot be directly applied to evaluate tone mapped images. Only a few objective assessment methods have been proposed for HDR images.

The HDR visible differences predictor (HDR-VDP) is a human visual system (HVS) based fidelity metric that aims to distinguish between visible (supra threshold) and invisible (sub threshold) distortions. The metric reflects the perception of distortions in terms of detection probability. Since HDR-VDP is designed to predict the visibility of differences between two HDR images of the same dynamic range, it is not applicable to compare an HDR image with an LDR image. A dynamic range independent approach was proposed in [14], which improves upon HDR-VDP and produces three types of quality maps that indicate the loss of visible features, the amplification of invisible features, and reversal of contrast polarity, respectively. These quality maps show good correlations with subjective classifications of image degradation types including blur, sharpening, contrast reversal, and no distortion. However, it does not provide a single quality score for an entire image, making it impossible to be validated with subjective evaluations of overall image quality. The purpose of the current work is to develop an objective.

II. RELATED WORK

Due to the reduction in dynamic range, TMOs cannot preserve all information in HDR images, and human observers of the LDR versions of these images may not be aware of this. Therefore, structural fidelity plays an important role in assessing the quality of tone-mapped images [19]. On the other hand, structural fidelity alone does not suffice to provide an overall quality evaluation.

Our system aims at the automatic detection of text. This is done by the algorithm. Fig. 1 shows the flow diagram of text detection algorithm. The algorithm steps are summarized as follows.

The SSIM approach provides a useful design philosophy as well as a practical method for measuring structural fidelities between images [20]. The original SSIM algorithm is applied locally and contains three comparison components − luminance, contrast and structure.

1. High-Dynamic-Range Image (HDR) of detail by capturing multiple photographs at different exposure levels and combining them to produce a photograph representative of a broader tonal range. The two primary types of HDR images are computer renderings and images resulting from High-Dynamic-Range Imaging (HDRI or HDR) is a set of techniques used in imaging and photography to reproduce a greater dynamic range of luminosity than possible using standard digital imaging or photographic techniques. HDR images can represent more accurately the range of intensity levels found in real scenes, from direct sunlight to faint starlight, and is often captured by way of a plurality of differently exposed pictures of the same subject matter. Non-HDR cameras take photographs with a limited exposure range, resulting in the loss of detail in bright or dark areas.

2. Tone mapping is a technique used in image processing and computer graphics to map one set of colors to another in order to approximate the appearance of high dynamic range images in a medium that has a more limited dynamic range. Print-outs, CRT or LCD monitors, and projectors all have a limited dynamic range that is inadequate to reproduce the full range of light intensities present in natural scenes.

3. The goals of tone mapping can be differently stated depending on the particular application. In some cases producing just aesthetically pleasing images is the main goal, while other applications might emphasize reproducing as many image details as possible, or maximizing the image contrast. The goal in realistic rendering applications might be to obtain a perceptual match between a real scene and a displayed image even though the display device is not able to reproduce the full range of luminance values.

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After applying all these 3 steps, we get a filtered image that contains only text regions.

III. TEXT INPAINTING

The SSIM approach provides a useful design philosophy as well as a practical method for measuring structural fidelities between images [20]. The original SSIM algorithm is applied locally and contains three comparison components − luminance, contrast and structure. Since TMOs are meant to change local intensity and contrast, direct comparisons of local and contrast are inappropriate. Let *x* and *y* be two local image patches extracted from the HDR and the tone-mapped LDR images, respectively.

IV. EXPERIMENTAL RESULTS

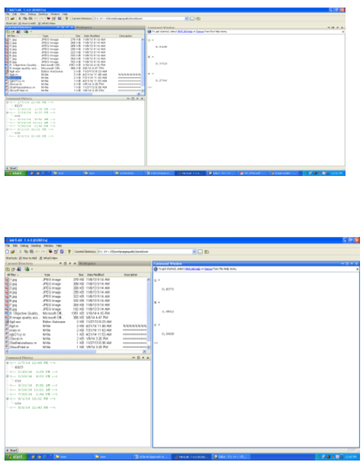

Fig 4 images generated with different parameter Q, S, & N values

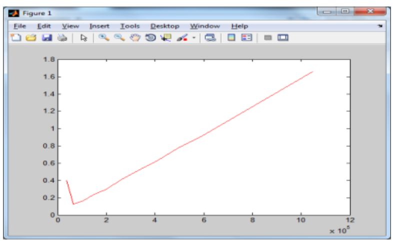

Fig. 5 Run time versus the number of image pixels of the proposed Algorithm.

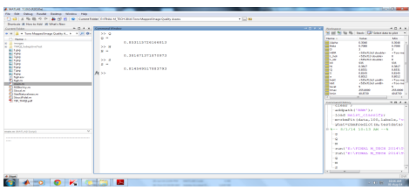

Fig 6. images generated with different parameter Q, S, & N values

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V. CONCLUSION

An objective model to assess the quality of tone mapped images is developed by combining a multi-scale structural fidelity measure and a statistical naturalness measure. The proposed measure not only provides an overall quality score of an image, but also creates multi-scale quality maps that reflect the structural fidelity variations across scale and space. TMQI is designed to evaluate greyscale images only, but most HDR images of natural scenes are captured in colour. One simple method to evaluate tone mapped colour images is to apply the TMQI to each colour channel independently and then combine them. Colour fidelity and colour naturalness measures may be developed to improve the quality measure. Simple averaging is used in the current pooling method of the structural fidelity map. Statistical naturalness measure is based on intensity statistics only. Advanced statistical models (that reflects the structural regularities in space, scale and orientation in natural images) may be included to improve the statistical naturalness measure. Using TMQI as a new optimization goal, many existing TMOs may be redesigned to achieve better image quality. Novel TMOs may also be developed by taking advantage of the construction of the proposed quality assessment approach. Finally, the current method is applied and tested using natural images only. The application scope of HDR images and TMOs is beyond natural images. For example, modern medical imaging devices often capture HDR medical images that need to be tone-mapped before visualization. The TMQI and optimization methods may be adapted to these extended applications.

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