Blind De-ghosting for Automatic Multi-Exposure Compositing (sap_0103)

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1 Introduction

High dynamic range (HDR) image, which faithfully represents the real world scene, needs to be tone mapped to a low dynamic range (LDR) image for display/printing purposes. In this work, we propose a novel method to generate an LDR image of a dynamic scene directly from multi-exposure images, captured using methods like Auto-Exposure Bracketting (AEB). Though there are methods such as [Mertens et al. 2009] for producing such an LDR image, they produce artifacts called 'ghosts' in case of moving objects in the scene. We propose a novel approach to determine the moving objects and eliminate them while compositing. We do not assume any knowledge of camera response function and the exposure settings, a must for existing works like [Gallo et al. 2009]. We show that the resultant LDR images are artifact-free and are faithful representations of the HDR images.

2 Related Work

Multi-exposure images can be composited to span the entire dynamic range of a scene [Reinhard et al. 2005]. The high dynamic range (HDR) image, thus produced, would faithfully represent the real world scene comprising of both brightly and poorly lit regions. The generation of HDR image requires one to estimate the camera response function (CRF) and to know the exposure settings. For such methods, dynamic scenes pose a challenge as the moving objects produce artifacts called 'ghosts' in the final image. For a dynamic scene, one has to perform additional operations to remove the ghosts introduced due to moving objects in the scene. This process, known as de-ghosting, can be performed by replacing the pixel intensities of the motion regions from one or more of the multi-exposure images without any local motion.

Let us first consider the method which does not require knowledge of camera response function and exposure settings to achieve this task. In order to avoid ghosting artifacts for dynamic scenes, one has to determine the regions of the scene which have motion and replace them with the appropriate intensity value from one of the multi-exposure images. Variance and entropy across the images can be used to perform such a task [Jacobs et al. 2008]. The main problem with such an approach is that we do not composite multiple images at the motion regions which result in reduced dynamic range (contrast). Also, the detection of motion blocks is also quite poor.

The de-ghosting process is very simple if one has the knowledge of the CRF along with the exposure settings. The CRF linearizes the pixel intensities which enable one to detect the motion regions from an image very effectively [Gallo et al. 2009]. This method enables one to composite multiple regions of the image leading to an increased dynamic range and can be used to generate high quality HDR images. In the present work, we extend the work by [Gallo et al. 2009] assuming that we have neither the knowledge of CRF nor the exposure settings for the given set of multi-exposure images.

3 Proposed Approach

Given a set of multi-exposure images, we assume that we have at least one image which does not have any motion. We use the patches from this image as reference to detect motion in the corresponding patches of the other images. The learning phase involves fitting a polynomial to the transfer function that relates intensity values of the reference image and the test image. We assume that there is no motion along 5-10 horizontal lines at the top of each image since the motion is mostly confined to the ground plane and use the corresponding intensity values to obtain the transfer function. In [Gallo et al. 2009] work, this function after CRF and exposure adjustments is always linear with unity slope, while in the proposed technique, this is estimated though a sixth order polynomial.

Let us consider two corresponding patches (of size say, 10 X 10) from the reference image and test image, respectively. We expect their intensities to follow the estimated transfer function if there were no motion in this patch location. To classify whether the given test patch has motion, we count the number of pixels in this patch which lie outside a given distance from the estimated transfer function. If the count exceeds a certain threshold, we classify the patch as having motion and do not consider the patch while compositing.

The same process is repeated to classify the patches of all the test images for motion. We then perform compositing on the corresponding patches which do not have motion using exposure fusion [Mertens et al. 2009]. The composited patches are assembled to get an image which may have visible seams along the patch edges. We match the intensity values across the patch boundaries to reduce the seams. We then employ the gradient domain technique similar to that used by [Gallo et al. 2009] to remove the remaining visible seams. These operations produce the final LDR image which depicts both the brightly and poorly lit regions of the dynamic scene equally well without any artifacts.

4 Conclusion

We have designed a novel technique to composite multi-exposure images of a dynamic scene without any knowledge of CRF and exposure settings. The proposed approach, which produces an LDR image, can be used to eliminate ghosts being produced while compositing dynamic scenes. The final LDR image produced using the proposed method is directly compatible with common displays and printers.

References

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