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Ghost Detection and Removal in HDR Images

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Abstract- **Digital cameras can only capture a limited range of images, when a user tends to take a photograph of any scene the areas that have a high intensity looks brighter and suppose if the image is captured from a dark scene the images will be of low intensity that is less brighter. When these images are taken in either of these scenes the output image will be a combination of images with low dynamic range. In order to get a clear and a high quality range of images, the technique was developed to obtain a high quality of image in a more convenient way that is known as high dynamic range imaging. The output images are called high dynamic range (HDR) images, since there were many techniques that were evolved for fusion. The two methods are fusion in radiance domain and fusion in image domain. The main criteria for taking a combination of several images are to take the image that is placed at a particular position that is constant. So, any object that has a motion in the scene it will result in causing a blurred image that is called as ghosting artifacts in the output HDR image. To identify the ghost objects in HDR image there are many methods namely, Variance based ghost detection, Entropy based ghost detection, Prediction based ghost detection, Pixel order relation, one of these techniques are used to identify ghost objects in the image.**

Eliminating the ghost object in the final HDR image is the main agenda of any method that solves the ghost problem. Many methods produces a different kind of outputs and can be divided into two main types. One is keeping a object at one particular position which has a motion, and another is eliminating all the objects that has a motion in it.

Keywords- **low quality range, fusion, entropy, ghost identification, ghost objects, ghost elimination.**

I. INTRODUCTION

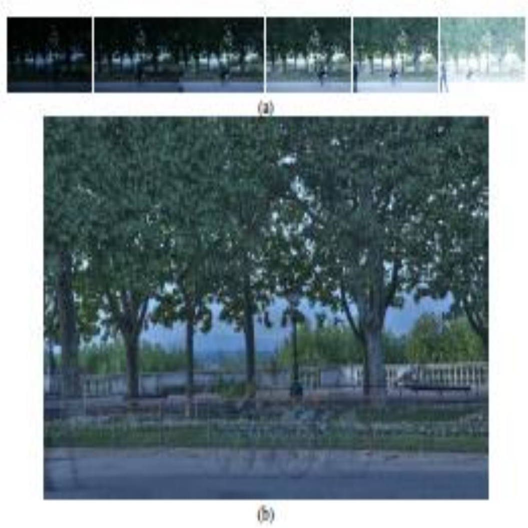
Cameras can only obtain a low quality range of images and most desktops and visual media also have low dynamic range due to the low capacity of sensors. HDR images can be obtained using either hardware or software methods. The most frequently used method for HDR image generation is based on the combination of various different exposures. For this the simpler and easier way to implement are affected by two major problems:

(i) One is the Misalignment.

(ii) Another is the Ghosting.

GHOSTING: Motion objects in the captured scene of an image will be shown in various positions in the final HDR image, thereby resulting in a ghost objects.

DEGHOSTING: The process of eliminating the ghost images from the obtained final HDR images is called Deghosting.



(a) LDR images. (b) HDR ghost image.

Fig (1) shows the set of seven images captured with varying intensities that is from high intensity to low intensity which are termed as LDR images. Fig (2) shows the result of combined LDR images into a single final HDR image. The motioned objects results in the ghost objects which leads to the two problems.

Initial problem can be overcome by positioning the camera on a table. The later problem has several defects because of its various exposures methods, as the moving objects cannot be rejected in the outside environment condition.

This drawback limits the application of HDR imaging in practice.

Classification of ghosts as

1. DISCRETE (ghost objects that are positioned with a large distance between them).
2. FLUID (ghost objects that are constant at one position but, wandering such as movement of leaves when the wind is blown).

There are three steps in obtaining a final ghost free HDR image

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1. FUSION
2. GHOST DETECTION
3. REMOVAL OF GHOST ARTIFACTS

1.FUSION

Fusion is a process of combining several low quality ranges of images into a single final high quality images. There are two different HDR image generation processes are FUSION IN THE RADIANCE DOMAIN and FUSION IN THE IMAGE DOMAIN. The performance of the methods that combine images in the radiance domain mainly depends on accurate estimation of the camera response function that is the time between which the user clicks the picture and the image is obtained in the camera. And these methods needs tone mapping that is, adapting the HDR image to be display-able in different desktops of the user. The main advantage of the image domain method is that they avoid the estimation of the camera response function and it does not need tone mapping to be performed.
Tone mapping is a direct method that is used in the radiance domain. By taking the set of images and combining them into a single HDR image that captures the entire scene. This radiance map can later be used for different processing or display applications.

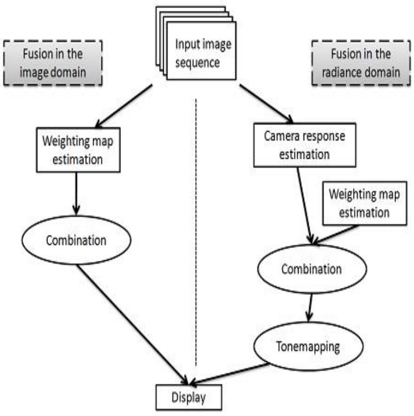

Fig: flowchart for fusion method

This HDR image generation method consists of three steps,
First**,** The camera response function is computed that is the time at which user flashes the camera and the image is captured. This function also eliminates any dislocations in the image acquisition process. And one limitation is that the developers do not always provide the camera response function. Different methods are introduced for the estimation of camera response function.
Second**,** All radiance maps are combined into an HDR image added specifically to store the pixel values.
Third**,** the user can obtain a display-able of a high quality images in their desktop through the tone mapping operator.
Let $\{L_k\}$ k=1…N be a set of N images with exposure. Given the camera response function f (), the HDR image is computed as the weighted average of pixels values across exposures using the following equation:

$$R_{uv} = \frac{\sum_{k=1}^{N} w(Z_{uv}^k) f^{-1}(Z_{uv}^k)/\Delta t_k}{\sum_{k=1}^{N} w(Z_{uv}^k)},$$

Here R signifies the combined radiance map, Z denotes the pixel value at location (u, v) in exposure L_k and W (Z_{uv}) is the weight of that pixel.

2.GHOST DETECTION

Ghost detection is the process of identifying the moving objects in the finally obtained HDR image from the fusion process. There are two types of motions in a dynamic scene,
(i) Constant background with a moving object, e.g. people walking on a road.
(ii) Fixed with static or dynamic objects with the moving background, e.g. Birds flying in the sky.
Some of the detection methods used is:

1. VARIANCE BASED GHOST DETECTION
2. ENTROPY BASED GHOST DETECTION
3. PREDICTION BASED GHOST DETECTION
4. PIXEL ORDER RELATION

VARIANCE BASED BLURRED DETECTION

This method is used to identify the objects that are blurred based on the weight age of the object.
The steps involved are:
Initially the camera response function is determined and the radiance maps are obtained. Then we calculate the radiance values at each spatial location (u, v).

$$\mathrm{VI}_{uv} = \frac{\sum_{k=1}^{N} w(Z_{uv}^k)(E_{uv}^k)^2 / \sum_{k=1}^{N} w(Z_{uv}^k)}{(\sum_{k=1}^{N} w(Z_{uv}^k)E_{uv}^k)^2/(\sum_{k=1}^{N} w(Z_{uv}^k))^2} - 1,$$

Z_{uv}^k

Pixel value at position (u, v) in exposure L_k

E_{uv}^k

Estimated radiance value at position (u, v) in exposure L_k

$$w(Z_{uv}^k) = \begin{cases} Z_{uv}^k & \text{if } Z_{uv}^k \le 127 \\ 255 - Z_{uv}^k & \text{if } Z_{uv}^k > 127 \end{cases}.$$

The regions where the threshold is less than the local variance measure are called as ghost regions.

$$G_{uv} = \begin{cases} 1 & \text{if } \mathrm{VI}_{uv} \ge \text{threshold} \\ 0 & \text{otherwise} \end{cases}.$$

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The threshold is kept to 0.18 for obtaining the normalized VI. For colored images such as RGB the maximum VI is calculated.

4. REMOVAL OF GHOST ARTIFACTS

If the user wishes to have a moving object in his image, then it is left to him to keep it in a constant location in a output HDR image and he can also remove the ghost objects that look blur by taking a several photographs of a moving image at a various location, instead of completely eliminating it.

There are various methods for blur removal that relies on the detected blurred map and the easiest way is to take the various exposure fusion methods in blurred -free regions while selecting a single reference exposure in blurred affected areas.

The estimation of the exposure depends on having an image that is less concentrated or the image with the high range of blur objects. Another method is used to estimate the valid number of exposures to be used in different blurred affected areas. This number is obtained for each r X r patch (r = 40), as the number of images in which the patch does not deviate from the patch in the reference image. The algorithm then builds the HDR image using different number of exposures on each detected blurred region.

The main objective of the ghost problem is to eliminate the ghost objects in the final combined HDR image that is obtained during ghost detection process. The results are obtained from different methods. First is to differentiate the method which removes the ghosting objects while keeping a single occurrence of the moving object.

1. BY KEEPING THE MOVING OBJECT AT A SINGLE INSTANCE

If the photographer needs the moving object to be highlighted, then it is convenient to fix the object at one particular position in the final HDR image, rather than completely eliminating the blur objects due to multiple appearances at several locations.

2. ELIMINATING ALL THE MOVING OBJECTS

In this process we finally obtain the HDR image that is free from the ghost objects based on image patch processing rather than computing with pixels individually. Here we use the different ghost affected areas that are detected by the number of exposures and use these exposures to obtain a final HDR image.

II. APPLICATIONS OF IMAGE FUSIONING

Due to the advancement in the technology, there are various applications of image fusioning where in the low dynamic range images of different intensities, the minute objects cannot be identified because of its variation in the intensities and hence one of the major advantages of the HDR image is that every minute objects can also be detected. This method is applicable in space where aliens can be captured that has movement that looks blur and also used in criminal offence to detect the Culprits. Image fusion has been used as an effective tool in medicine. Fused multi modality medical images to improve diagnosis and treatment planning. Image fusion has been used in defense applications for situation awareness surveillance target tracking, intelligence gathering and person authentication. Image fusion has also been extensively used in remote sensing in interpretation and classification of aerial and satellite images.

III. CONCLUSION

There are different methods for generation of HDR image namely fusion in image domain, here both the methods are for creating HDR image, detection of the ghost particle in HDR image is quite difficult and there are several methods proposed before, there is no proper method for removing ghost objects in HDR image that has been proposed previously. Some methods remove only fluid ghosts and not discrete ghosts and some for removing the discrete ghosts and not for the fluid ghosts. There is no single method for removing both the ghost particles. Hence we use this method to remove both the fluid and discrete ghosts which can be helpful for many applications. The high quality ghost image is obtained by fusing the low quality images of different exposures and two methods have been used to solve this ghost problem. Each method is implemented and a comparison is made with the previously proposed method with the quantitative evaluation of the accuracy of different methods in detecting ghost regions with several exposures. Methods that combine exposures in the radiance domain are time efficient as they avoid the camera response function and tone mapping. The proposed system overcomes all the disadvantages faced by the earlier methods. Hence, it is the best technique to be used for obtaining the ghost free HDR image.

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