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Multiple Exposure Image Fusion

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Abstract*: in many cases scene's dynamic range is greater than digital camera dynamic range. In such cases the user needs to capture multiple exposures of the same scene, then combines them together. Exposure can be varied either by changing the shutter speed or by changing the aperture. In this paper we preferred to change the shutter speed over aperture. The main reason for that is changing aperture leads to depth of field problems.*

Keywords: *Aperture ;Dynamic range; Shutter speed;*

I. INTRODUCTION

In general dynamic range refers to the ratio between the maximum and minimum measurable light. For an imaging sensor dynamic range dynamic range refers to the ratio between full well capacity and noise. Naturally scene's dynamic range can be up to 100,000 and the sensor dynamic range is always less than that.

Fig 1: Image captured with shutter speed 1\3200 sec

In order to get the full dynamic range of the scene, we must combine several exposures together. Different exposures can be achieved by changing the shutter speed or by changing the aperture. Shutter speed refers to the amount of time shutter remains open in order to acquire the image. If the shutter remains open for long amount of time then the sensor collects more amount of light and the picture appears too bright. If the shutter closes quickly then the sensor collects less amount of light and the picture appears dark.
We can clearly observe that the figure 1 darker and the figure 2 is brighter. In the figure 1 background details are clearly visible and in the figure 2 the tree details are correctly visible.

Fig 2: Image captured with shutter speed 1\50 sec

Fig 3: Image captured with F#-32

We can also change the exposure values by changing the f-number. Figure 3 and 4 are captured with different f-numbers and different shutter speed values. We can clearly see that background is unfocused. During the fusion phase these details will be completely not useful. Hence we preferred to change the shutter speed values. Both figure 3 and 4 are collected from Wikipedia.

Fig 4: Image captured with F#-5

II. RELATED WORK

Different auto exposure algorithms are introduced in order to correctly expose the scene. However, if the scenes dynamic range is greater than the imaging device dynamic range it is not possible to get the all details in a single image.

Many AE algorithms have been developed [1-4] to deal with high-contrast lighting conditions. Some of them employ fuzzy method while others use various ways of segmentation. However, most of these algorithms have some drawbacks on either their accuracy or on the complexity, or both while estimating lighting conditions.

According to [1], it is difficult to discriminate back-lit conditions from front-lit conditions using histogram methods [2], [3]. Further simulations in this paper shows that the tables and criteria used to estimate lighting conditions are confusing and not consistent. Other algorithms [3], [4] used fixed-window segmentation methods to estimate the brightness and lighting conditions. Besides, these papers and [1] only considered images with only one main object. Therefore, these algorithms are not flexible and do not work well with other images in which a main object does not exist **[5]**.

In real implementation, the idea works as follows: The authors, proposed different optimum brightness values (Bl_{opt}) for different lighting conditions. To identify the lighting conditions, after capturing the first frame, the brightness value mean (Bl_{mean}) and median (Bl_{med}) are calculated. The difference of these two values is represented with D_L. In order to obtain the most suitable optimal values of Bl_{opt} for normal lighting (Bl_{opt}^{norm}), back lighting or high contrast (Bl_{opt}^{bkdr}) lighting conditions, and lighting conditions when the current picture is over exposed (Bl_{opt}^{over}), many pictures were taken by the authors, in different lighting conditions. The mid-tone range Bl_{mt} is set to [100, 130].

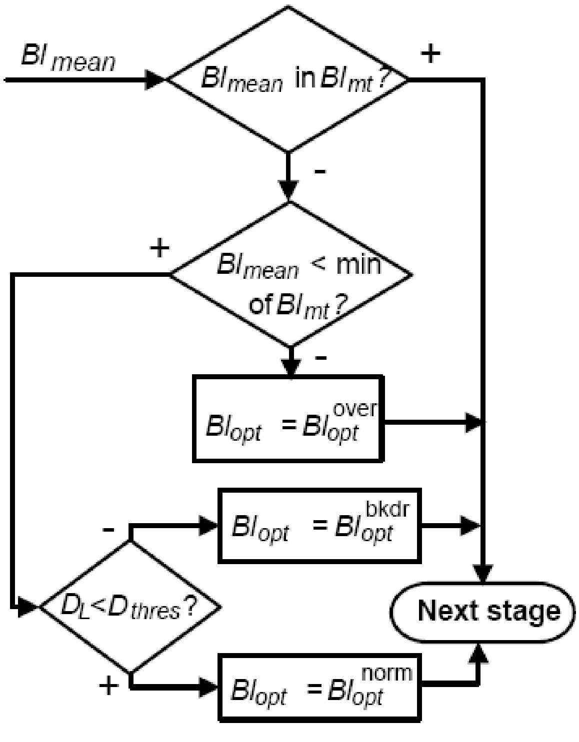

Fig 5: Deciding value for Bl_{opt}

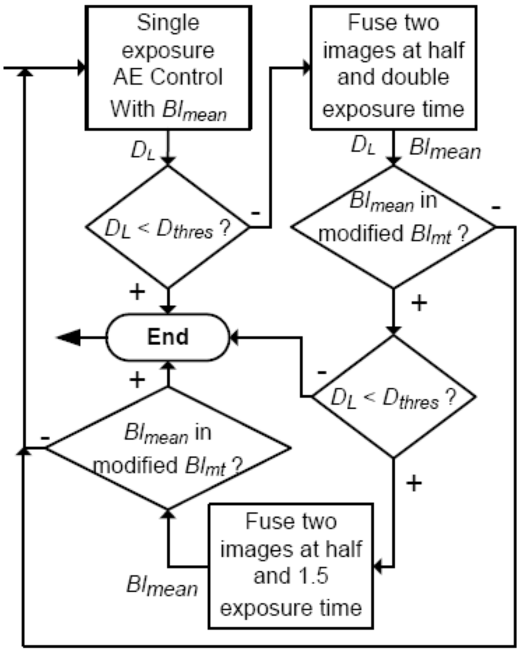

Fig 6: Multiple Exposure algorithm

III. PROPOSED ALGORITHM FOR HDR CAPTURING

Our algorithm basically consists of four parts. In the first part the end user should capture the image with the exposure settings suggested by the digital camera. Currently most of the digital cameras come up with the auto mode. If the user selects auto mode then automatically camera suggests shutter speed, aperture, ISO for a given scene. Once the camera suggests the exposure values, based on the exposure values suggested by the camera the end user captures a photograph.

Fig 7: Image captured with auto mode

In the second step HDR algorithm tries to identify the under exposed regions. In the under exposed region pixel values are close to zero. Once the algorithm identifies those regions it tries to find the proper exposure values. Proper exposure values can be found by increasing the shutter speed values. Once we increase the shutter speed values all the shadow details will be correctly exposed and the remaining details will be over exposed. Once we found the correct exposure settings for the under exposed regions the user need to capture the image.

Fig 8: All the shadow details are correctly captured

In the third step HDR algorithm tries to find the over exposed regions. In the over exposed region pixel values are close to 255. Once the algorithm finds the over exposed regions, it tries to find the correct exposure values. By decreasing the shutter speed we can correctly capture the highlight details. Once the camera identifies the correct exposure values

Fig 9: All the highlight details are captured

We fused all the above three images and the result is displayed in the Figure 10. We can clearly observe that all the high light details and shadow details are captured.

Fig 10: Fused image

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