Constant Exposure Method for DSC IGBT Strobe

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Abstract

A constant exposure method for DSC IGBT strobe is proposed. This method is based on two lookup tables (exposure and energy table). In this method, light box is used to generate exposure table and different flash time is used to generate energy table. Through exposure table and preflash result, we can get digital number ratio of preflash to main flash. This ratio and energy table can be used for predicting the strobe main flash time under different brightness conditions.

Introduction

Strobe Controller

There are two general strobe controllers used to exposure compensation, SCR and IGBT. Although SCR has an advantage of high illumination but its limitation in luminosity control is a disadvantage for DSC's AE function, especially in main flash predict method by preflash. If a strobe is necessary to be treated as a precise AE factor, it would need IGBT style for correct trigger time. Advantage of IGBT's fast response time can implement other function for red eye reduce and night shot. According to meet flexible strobe application, more and more DSC adopts IGBT design to do exposure compensation.

Factor of Illumination

As one DSC capture image, first function is to do AE (auto exposure), auto AF (auto focus), and then AWB (auto white balance). If one camera cannot have a good AE, AF will not run especially under low light condition. AE system will try its best to adjust aperture value, exposure time and ADC (analog to digital converter) gain. However, it still does not have enough exposure, IGBT strobe would add into exposure system to light on the environment by its precise trigger time control.

There is a fast AE function can be used in DSC's FW (firmware) design. It is defined EV = AV + TV = SV + BV.[1] EV is exposure value; AV is aperture value; TV is time value; SV is speed value; BV is brightness value. From this function, it is obvious that AE would relate to these factors to affect illumination into DSC. When DSC reaches its limitation to adjust above factor and it still cannot satisfy enough exposure. It is strobe function to illuminant lighter on background.

Although strobe can assist exposure, exposure application of strobe has to be understood being affected by environment factor, photography distance and environment luminance. It is the case to build a method consider above factor. This paper main idea is to implement strobe compensates exposure after lots of experiment data to eliminate photography distance measurement without inverse calculation by zoom lens or using additional laser meter.

Experiment

Strobe is a high luminance component for exposure compensation but AE function related to strobe is good or not based on character of sensor's quantum efficiency and strobe's trigger luminance. In order to implement strobe operation, it is to understand how much light should strobe provide to background under what kind of environment. Therefore, it should be obtained in advance, the sensor's illuminant curve and strobe's energy curve.

Exposure Table

As DSC aim to uniform light source, the total exposure value would be calculated by 18% reflectance in nature. After AE run the exposure to meet 18% reflectance, it will get a proper exposure and then AF, AWB. Exposure in DSC is better to be linear with illumination in theory, but it is sometimes not true due to sensor and ADC. It is the reason to have DSC's exposure character and then put the result for strobe control.

The experiment of exposure table is to make DSC aim to uniform light source and get camera's response by varying light intensity. Figure 1 is the result normalized the EV (exposure value) and DN (digital number). It would have a fitting cure and function 1 to be used in exposure control.

$$DN = f(EV) \tag{1}$$

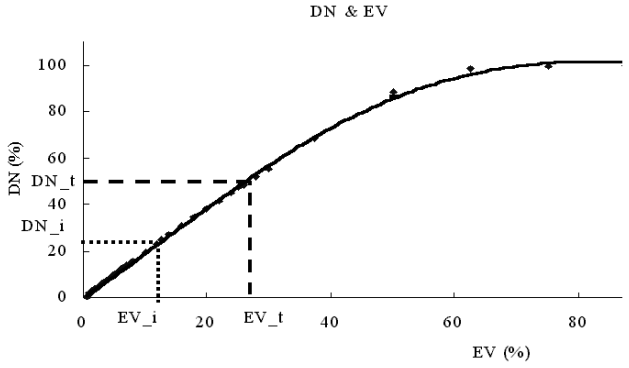

Figure 1. Exposure table

Energy Table

Main function of strobe is to add more light to background but not every strobe has the same illuminance ability. It would be refer to strobe's character, like strobe tube, reflector, IGBT control & capacitor, and environment factor, like photography distance and environment luminance. When strobe uses the same energy, IGBT trigger time, the response of sensor would be different by photography distance. Near distance would make larger response and far distance is inverse. Refer to Figure 2, experiment setup would make the energy curve, and then the curves combine for strobe's energy character. For a DSC without function of distance measurement, the energy table would be normalized the energy scale with several photography distance in strobe's limitation of GN (guide number). Figure 3 presents energy table and the data includes three distances we had experimented and normalize three-curve form one. It has a trend curve of fitting function 2.

$$EN = f(ST) \tag{2}$$

EN means energy number and ST is strobe trigger time.

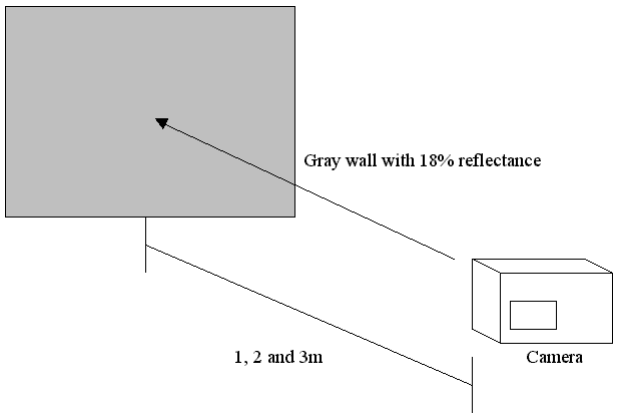

Figure 2. Experiment setup for energy table

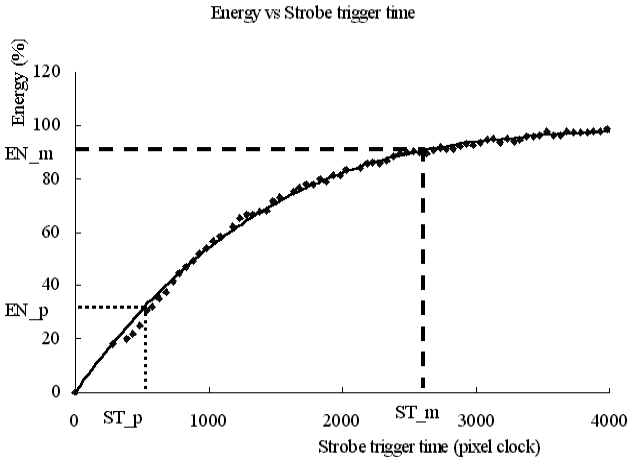

Figure 3. Energy table

Integrate and Calculation Method

These two curves would be used when strobe added into exposure compensation. When AE is stable and need more lights, exposure table would be applied to get the DN difference. When AE stop, initial DN_i would be calculated. Put this DN_i into function (1) to get initial EV_i. In exposure compensation, the target EV_t would be set into FW to be a standard of AE implementation. EV_t also can be put into DN=F (EV) to get exposure target DN_t. The difference, DN_d = DN_t – DN_i, would be compensate by strobe. However, camera would have different DN response by different distance under the same strobe trigger time, the same energy output. Therefore, it would be an important thinking to use preflash to predict the relationship of energy and DN. When illumination result from preflash, the DN_p would be larger than AE initial value DN_i, the energy scale factor (SF) would be calculated by

$$SF = \frac{(DN\_t - DN\_p)}{(DN\_p - DN\_i)} \tag{3}$$

The main flash energy would be calculated by

$$EN\_m = EN\_p \times SF \tag{4}$$

Refer to energy table, we can inverse to search the trigger time by function (2). Put EN_m into the function, ST_m, triggered time for main flash, can be calculated.

Result

In order to verify this calculation method is right for camera, the flow in Figure 4 was saved into camera's firmware (FW). Then we use the same set up in Figure 2 to capture with strobe for different photographic distance. Totally, we have images for three distances, and the captured images show in Figure 4.

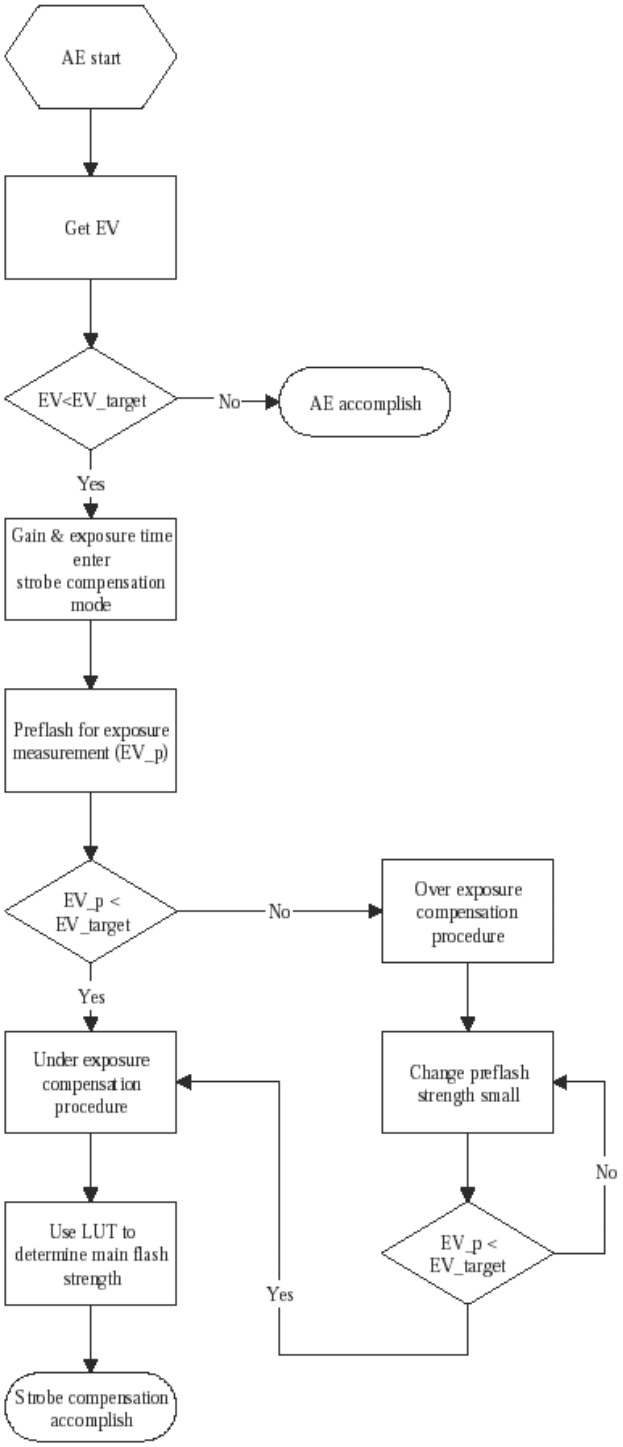

Figure 4. Strobe flow

Figure 6 gets specified area in the three images in Figure 5. And calculated its related R, G, & B output data. From the curve, the output of R, G and B channel are similar by different photographic distance. This result means the strobe can use for exposure compensation in different distance where it is still limited in its GN.

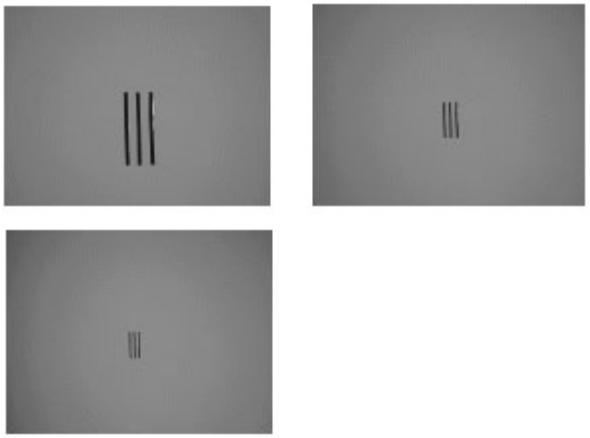

Figure 5. Image output - the three images were captured in1m, 2m and 3m. Centerline pair is use for AF.

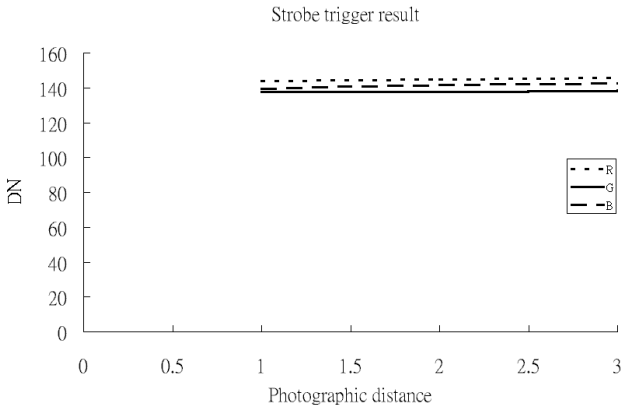

Figure 6. Strobe trigger result

Discussion & Conclusion

This paper would like to introduce a simple control method for strobe exposure compensation without considering photographic distance. Regarding to Figure 4, if the exposure value over target value, the algorithm would small strobe's strength to under target, this is because energy table we put in FW were cut off in the stable region where the exposure would not add even strobe strength increasingly. Due to the end of this energy curve is not an absolute point, the predict strobe strength would be better by the way of under strobe. Through this method may get a stable exposure by two LUT, but it needs preflash under exposure target and result in more preflash times without distance.

This method is already verified by designed experiments. The next is to implement exposure and energy table for every DSC. On line calibration for every camera's strobe is necessary and this precise compensation would be the future.

Reference

1. General purpose photographic exposure meters (photoelectric type)-guide to product specification, ANSI IT 3.302, 1994

Biography

Wen-Lung Chou worked for ITRI Taiwan from 1990 to 1997. He ever studied in color science from University of Derby, UK. He is currently working in image quality issue at Tekom Technologies, Inc. His research interests include image color science, image capture system calibration method and digital image processing.

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