EXPOSURE VALUES

Synonyms: *Sensor's exposure characterization.*

Definition: *Numerical values used to specify the relationship between the f-number and the exposure duration which together with ISO sensitivity are important camera settings necessary to form a balanced image with respect to the involved imaging system.*

Introduction

The overall quality of captured images usually depends on the exposure of image sensors to light. Digital consumer devices use various ad-hoc strategies and heuristic methods to derive exposure setting parameters [1]. Typically such techniques are completely blind with respect to the specific content of the involved scene. Fully-automatic techniques are often based on average/automatic or more complex matrix/intelligent exposure metering concepts. Others techniques provide photographers with a certain control over the exposure selection. The most important aspect of the exposure duration is to guarantee that the acquired image falls in a good region of the sensors sensitivity range. In many devices, the choice of exposure values plays a crucial role in adjusting the overall image intensity of captured images. Earlier digital cameras used a separate metering system to set exposure duration rather than using data acquired from the sensor chip. Integrating exposure-metering function (i.e., through-the-lens or TTL metering) into the main sensor may reduce system cost. To specify the relationship between the f-number (F) and exposure duration (T) the imaging community uses exposure values:

$$EV = \log_2\left(\frac{F^2}{T}\right) = 2\log_2(F) - \log_2(T)$$

The f-number values (also called aperture values) characterize the size of the hole that the light passes through in the rear of the lens, relative to the focal length. The smaller the f-number, the more light gets through the lens. Thus, the EV becomes smaller as the exposure duration increases, and it becomes larger as the f-number grows. Most auto-exposure algorithms work taking first a picture with a predetermined exposure value (EV_{pre}). After that acquired RGB values are converted to brightness B and a single value B_{pre} is derived from all B values by calculating their center-weighted mean or median or using more sophisticated methods such as matrix-metering. Based on linearity assumption, the optimum exposure value (EV_{opt}) can be seen as one that permits correct exposures [1], [2]. The picture taken at EV_{opt} should give a number close to a predefined ideal value B_{opt}, thus implying the following:

$$EV_{opt} = EV_{pre} + \log_2(B_{pre}) - \log 2(B_{opt})$$

The ideal value B_{opt} for each algorithm is typically selected empirically.

Figure 1. Examples of images acquired using different exposure settings: (left) low-exposure, (middle) medium exposure, and (right) high-exposure.

Existing algorithms mainly differ in the approach employed to derive B_{pre} from the picture. Although a number of methods were designed and used in practice for regulating the exposure, it is not rare for images to be acquired with a nonoptimal or incorrect exposure (see Figure 1).

See: Digital camera, dynamic range, video stabilization

References

1. S. Battiato, A. Bosco, A. Castorina, G. Messina, "Automatic Image Enhancement by Content Dependent Exposure Correction", EURASIP Journal on Applied Signal Processing, vol. 12, pp. 1849-1860, 2004.
2. R.C. Gonzalez, R.E. Woods, "Digital Image Processing", Third Edition, Prenctice Hall, 2007.