

MOTION BLURRING

Synonyms: Directional blurring

Definition: A specific kind of directional blurring due to the relative motion between the camera and the scene.

Imaging devices are usually not able to capture still images in an instantaneous way because image sensors collect photons for a certain period of time. Motion blur is caused by a moving scene point that spreads out several pixel locations during the sensor's exposure. The motion blurring can be defined as global degradations caused by movements during the image capture process. As shown in Figure 1, these movements are typically associated with the camera, long exposure times, and scene changes.



Figure 1. Motion blurring examples.

In general, a blurred or degraded image can be approximated as $g = h * f + n$, where g is the blurred image, h is the distortion operator also called the point spread function (PSF), $*$ denotes the convolution, f is the original true image and n is the additive noise introduced during image acquisition. If blurring occurs due to the uniform linear motion between the image and the sensor during image acquisition, then it is possible to derive the analytical form of the function H in the Fourier domain [1]. Suppose a planar motion with time varying components in the x and y directions, respectively. The total exposure at any point is obtained by integrating instantaneous exposure over the time interval during which the imaging system shutter is open:

$$H(u, v) = \int_0^T e^{-j2\pi[ux_0(t) + vy_0(t)]} dt$$

Assuming that shutter opening and closing take place instantaneously, then for the duration T of the exposure it follows that u and v are the corresponding frequencies in the Fourier domain. The function H can be used to restore the original image by applying image deconvolution algorithms [1], [3]. However, in real cases, the blurring model is unknown, thus requiring blind deconvolution approaches [3] or some heuristic strategies [2].

See: Video stabilization, video codec, exposure settings.

References

1. R.C. Gonzalez, R.E. Woods, "Digital Image Processing", Third Edition, Prentice Hall, 2007.
2. Q. R. Razligh, N. Kehtarnavaz, "Image Blur Reduction For Cell-Phone Cameras Via Adaptive Tonal Correction", in Proceedings of IEEE International Conference on Image Processing, ICIP'07, pp.113-116, 2007.
3. P.A. Jansson, "Deconvolution of Image and Spectra", Academic Press, 1997.