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We are assuming that I and J are of same dimensions. Also, we assume that in $I + J$ corresponding pixel values of each image gets added directly. There is no after-scaling to compensate when the intensities go out of range.

Now, let I, J, K be the random variables for these three images respectively. Now,

$$\mathsf{P}_K(k) = \sum_{i=-\infty}^{\infty} \sum_{j=-\infty}^{\infty} \mathsf{P}_{IJ}(i,j) \tag{1}$$