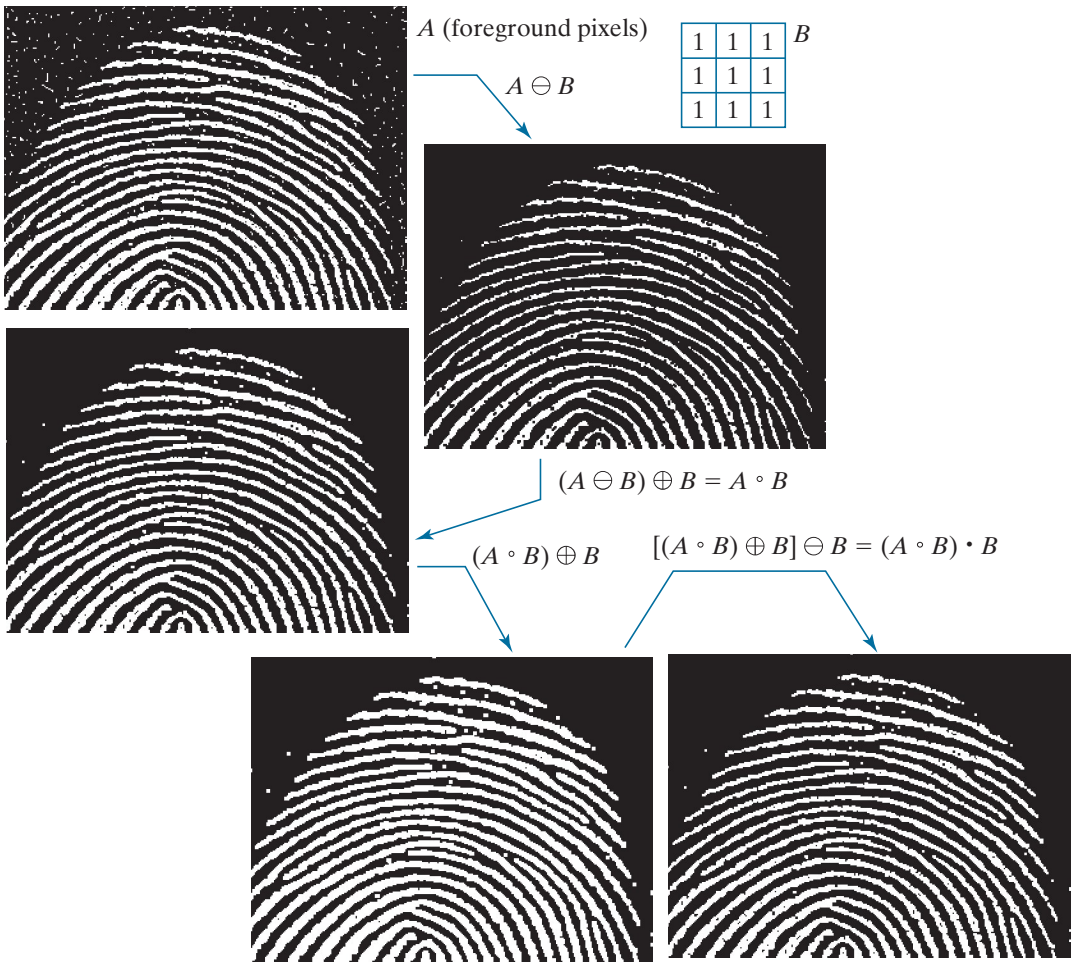

a b
d c
e f

FIGURE 9.11
(a) Noisy image. (b) Structuring element. (c) Eroded image. (d) Dilation of the erosion (opening of A). (e) Dilation of the opening. (f) Closing of the opening. (Original image courtesy of the National Institute of Standards and Technology.)

With reference to the explanation of Eq. (9-4), we show the morphological HMT operation working directly on image I, to make it explicit that the structuring elements work on sets of foreground *and* background pixels simultaneously.

structuring elements: B_1, for detecting shapes in the foreground, and B_2, for detecting shapes in the background. The HMT of image I is defined as

$$\begin{aligned} I \circledast B_{1,2} &= \left\{ z \middle| (B_1)_z \subseteq A \text{ and } (B_2)_z \subseteq A^c \right\} \\ &= (A \ominus B_1) \cap (A^c \ominus B_2) \end{aligned} \tag{9-16}$$

where the second line follows from the definition of erosion in Eq. (9-3). In words, this equation says that the morphological HMT is the set of translations, z, of structuring elements B_1 and B_2 such that, *simultaneously*, B_1 found a match in the foreground (i.e., B_1 is contained in A) *and* B_2 found a match in the background (i.e., B_2 is contained in A^c). The word "simultaneous" implies that z is the *same* translation of both structuring elements. The word "miss" in the HMT arises from the fact that B_2 finding a match in A^c is the same as B_2 not finding (missing) a match in A.

Figure 9.12 illustrates the concepts just introduced. Suppose that we want to find the location of the origin of object (set) D in image I. Here, A is the union of all object sets, so D is a subset of A. The need for two structuring elements capable