

i. e., the result for filter H_4^K is simply the negative result for filter H_0^K . The directional outputs D_0, D_1, \dots, D_7 for the eight **Robinson** filters can thus be computed as follows:

$$\begin{aligned} D_0 &\leftarrow I * H_0^K & D_1 &\leftarrow I * H_1^K & D_2 &\leftarrow I * H_2^K & D_3 &\leftarrow I * H_3^K \\ D_4 &\leftarrow -D_0 & D_5 &\leftarrow -D_1 & D_6 &\leftarrow -D_2 & D_7 &\leftarrow -D_3. \end{aligned} \quad (7.22)$$

The edge strength E^K at position (u, v) is defined as the maximum of the eight filter outputs; i. e.,

$$\begin{aligned} E^K(u, v) &\triangleq \max(D_0(u, v), D_1(u, v), \dots, D_7(u, v)) \\ &= \max(|D_0(u, v)|, |D_1(u, v)|, |D_2(u, v)|, |D_3(u, v)|) \end{aligned} \quad (7.23)$$

and the strongest-responding filter also determines the local edge orientation as

$$\Phi^K(u, v) \triangleq \frac{\pi}{4} j, \quad \text{with } j = \operatorname{argmax}_{0 \leq i \leq 7} D_i(u, v). \quad (7.24)$$

In practice, however, this and other “compass operators” show only minor benefits over the simpler operators described earlier, including the small advantage of not requiring the computation of square roots (which is considered a relatively “expensive” operation).

7.3.4 Edge Operators in ImageJ

The current version of ImageJ implements the Sobel operator (as described in Eqn. (7.10)) for practically any type of image. It can be invoked via the

Process → Find Edges

menu and is also available through the method `void findEdges()` for objects of type `ImageProcessor`.

7.4 Other Edge Operators

One problem with edge operators based on first derivatives (as described in the previous section) is that each resulting edge is as wide as the underlying intensity transition and thus edges may be difficult to localize precisely. An alternative class of edge operators makes use of the second derivatives of the image function, including some popular modern edge operators that also address the problem of edges appearing at various levels of scale. These issues are briefly discussed in the following.