for the region that can be used for classification or comparison with other regions. The best features are those that are simple to calculate and are not easily influenced (robust) by irrelevant changes, particularly translation, rotation, and scaling.

11.4.2 Geometric Features

A region $\mathcal{R}$ of a binary image can be interpreted as a two-dimensional distribution of foreground points $\boldsymbol{x}_i = (u_i, v_i)$ within the discrete plane $\mathbb{Z}^2$,

$$\mathcal{R} = \{\boldsymbol{x}_0, \boldsymbol{x}_1 \ldots \boldsymbol{x}_{N-1}\} = \{(u_0, v_0), (u_1, v_1) \ldots (u_{N-1}, v_{N-1})\}.$$

Most geometric properties are defined in such a way that a region is considered to be a set of pixels that, in contrast to the definition in Sec. 11.1, does not necessarily have to be connected.

Perimeter

The perimeter (or circumference) of a region $\mathcal{R}$ is defined as the length of its outer contour, where $\mathcal{R}$ must be connected. As illustrated in Fig. 11.14, the type of neighborhood relation must be taken into account for this calculation. When using a 4-neighborhood, the measured length of the contour (except when that length is 1) will be larger than its actual length. In the case of 8-neighborhoods, a good approximation is reached by weighing vertical segments with 1 and diagonal segments with $\sqrt{2}$. Given an 8-connected chain code $\boldsymbol{c}'_{\mathcal{R}} = [c'_0, c'_1, \ldots c'_{M-1}]$, the perimeter of the region is arrived at by

$$\mathsf{Perimeter}(\mathcal{R}) = \sum_{i=0}^{M-1} \mathrm{length}(c'_i) \tag{11.7}$$

$$\text{with} \quad \mathrm{length}(c) = \begin{cases} 1 & \text{for } c = 0, 2, 4, 6, \\ \sqrt{2} & \text{for } c = 1, 3, 5, 7. \end{cases}$$

However, with this conventional method of calculation,[9] the *real* perimeter ($P(\mathcal{R})$) is systematically overestimated. As a simple remedy, a general correction factor of 0.95 works satisfactory even for relatively small regions:

$$P(\mathcal{R}) \approx \mathsf{Perimeter}_{\mathrm{corr}}(\mathcal{R}) = 0.95 \cdot \mathsf{Perimeter}(\mathcal{R}). \tag{11.8}$$

[9] Note that the tools in ImageJ's Analyze→Measure menu use a different approach for computing a region's perimeter than the one described here.