Vectorisation of Sketched Drawings using Co-occurring Sampling Circles

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1 | Introduction

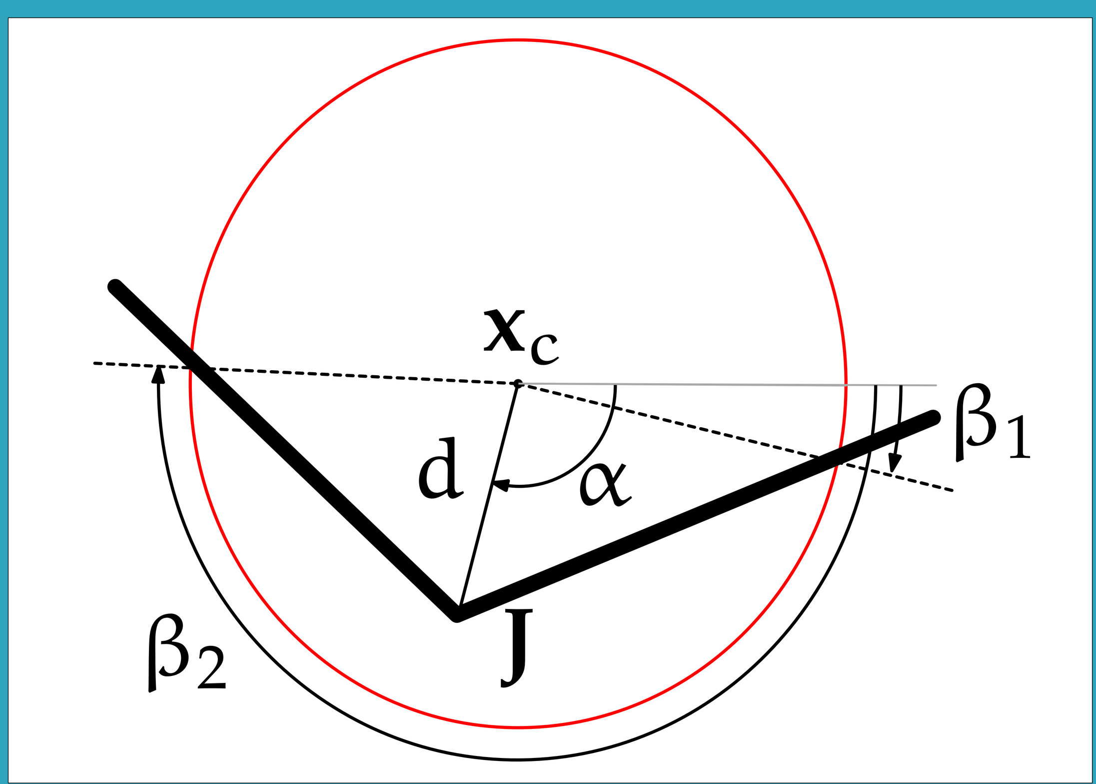
Drawing vectorisation algorithms convert raster drawings into a vector format that can be used by computer-aided design tools. Vectorisation techniques typically require that the drawing is binarised before lines can be sampled to obtain a vector representation of the drawing.
Such an approach may be problematic if the image back-ground does not have a uniform intensity.

2 | Contribution

- An alternative vectorisation algorithm that can work directly on grey-level images.
- Junctions can be localised from non centred sampling circles and thus, the drawing can be sampled sparsely.

3 | Theory

The centre $\mathbf{x}_c$ of a circle sampler is used as a local point of reference.



The junction point is then defined by:

$$\mathbf{d} = [d, \alpha]$$

At the junction, line segments with a line orientation θ with the horizontal will intersect the circle sampler at $\beta(\theta)$

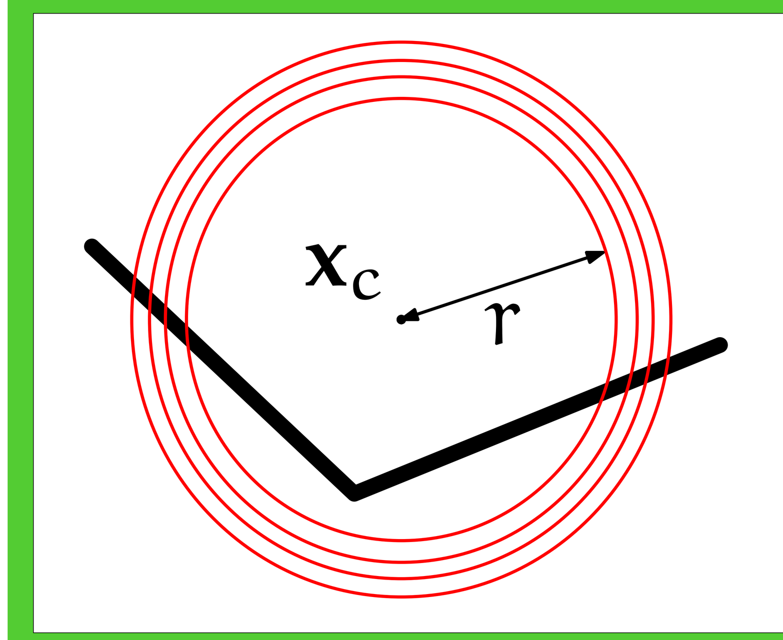
$$\beta(\theta) = f_{r,\mathbf{d}} = \theta \pm \sin^{-1}\left(\frac{d}{r}\sin(\alpha - \theta)\right)$$

The grey-level intensity on the circle circumference can therefore be expressed as

$$I_{r,\mathbf{d}}(\beta(\theta)) = \delta\left(\beta - f_{r,\mathbf{d}}\right)$$

where $\delta(\cdot)$ is the Dirac delta function

4 | Locating the junction point



Since θ and $\mathbf{d}$ are unknown, we can determine their values by scaning over all θ and $\mathbf{d}$ and search along β on the sampler circle circumference for evidence of line segments. This evidence can be accumulated in a co-occurrence matrix:

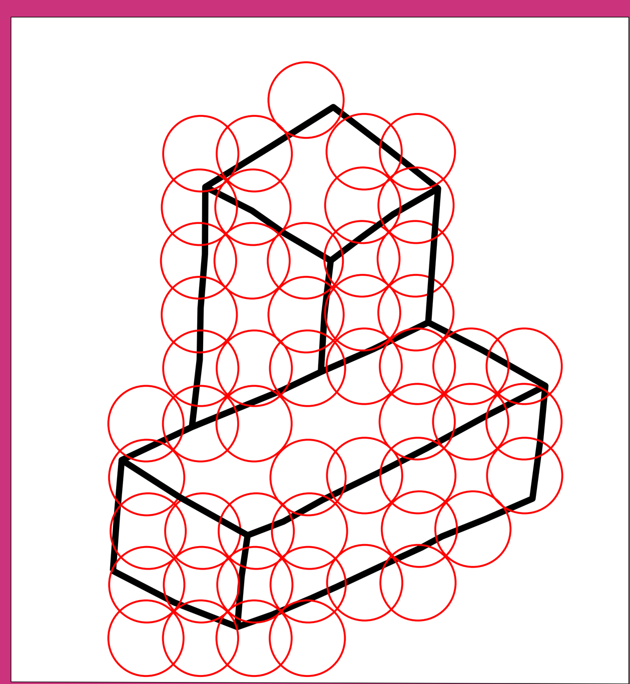
$$S_{\mathbf{d}}(\theta, \Delta\theta) = \frac{1}{M}\sum_{m=1}^{M} I_{r_m}(\beta(\theta)) I_{r_m}(\beta(\theta + \Delta\theta))$$

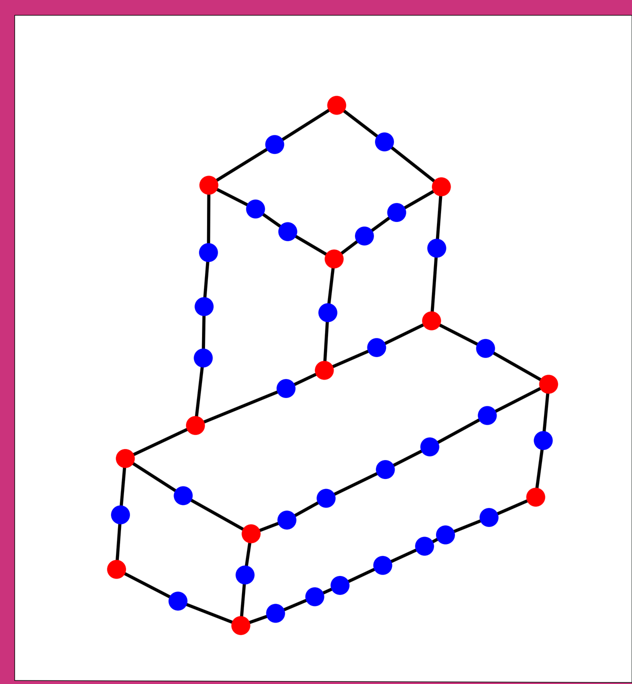
where M is the total number of concentric circle samplers

The junction poistion and line orientations are then estimated from:

$$[\hat{\theta}, \hat{\mathbf{d}}] = \arg\{\max\{S_{\mathbf{d}}(\theta, \Delta\theta)\}\}$$

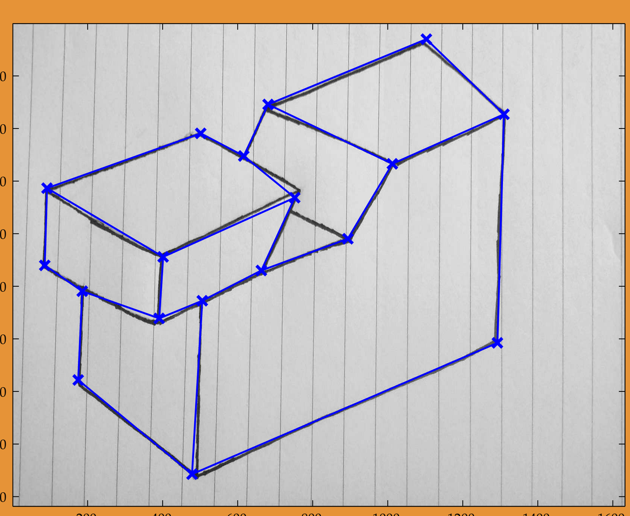
5 | Drawing vectorisation

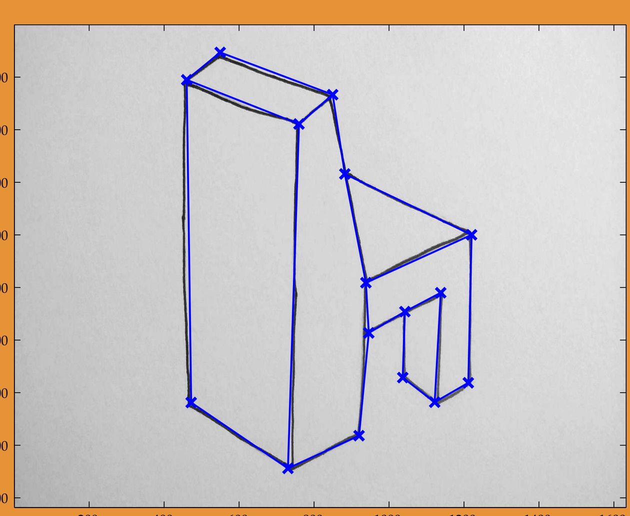


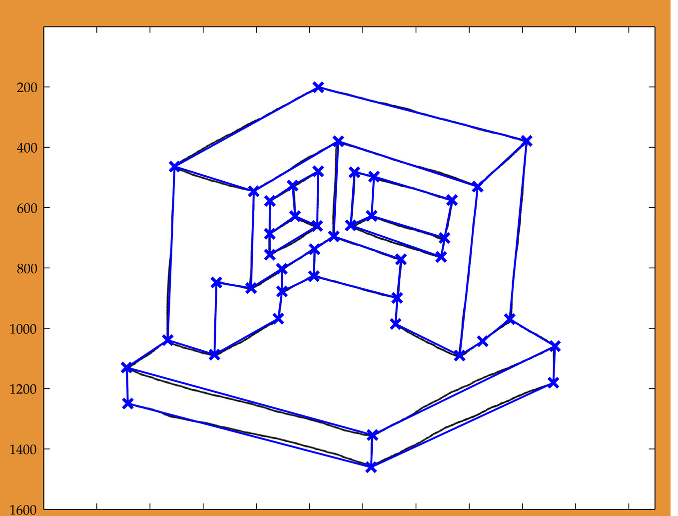


- The drawing is sampled with multiple concentric circles, evenly distributed across the image.
- Junction points are located from these circles
- A topological graph structure is then used to link the junction points and hence vectorise the drawing

6 | Results







The vectorisation algorithm was evaluated on several drawings conainting between then, 310 junctions, of which 306 junctions were detected with a localisation accuracy of 4.7 ± 2.3 pixels,