Contents

1 Statics/Kinematics of Perspective Projection

Backprojection map:
Scene-to-Image: $F^{*-1}\begin{bmatrix}\frac{\cos\sigma}{r}, 0\\ 0, \frac{1}{r}\end{bmatrix}$ and,
$\text{Image} - \text{to} - \text{Scene} : \text{F} * \begin{bmatrix}\frac{r}{\cos\sigma}, 0\\ 0, r\end{bmatrix}$

2 Line Drawing Interpretation

2.1 Definitions

Contour generator: is a 3D space curve.
Contour: is its projection on an image.
Limbs: these occur when a surface curves smoothly and hides itself.
Edges: are when there are discontinuities in surface normals.

2.2 Symbols

+ convex
- concave
> sharp changes in visibility (i.e. occluding edges)–these can only arise from convex edges
>> occluding contours (smooth surface that occludes itself)

The convention with the arrows (>,>>) is that if you are walking like an ant on an edge, following the direction of the arrow, then the belonging surface is on your right.

2.3 Discontinuities

z - changes in depth arise from occluding limbs/edges.
p(rho) - variations in reflectances from surface markings etc.
L(Illumination) - shadows.

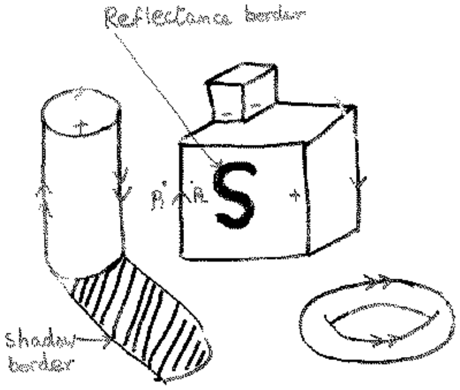

Figure 1: Some sample diagrams

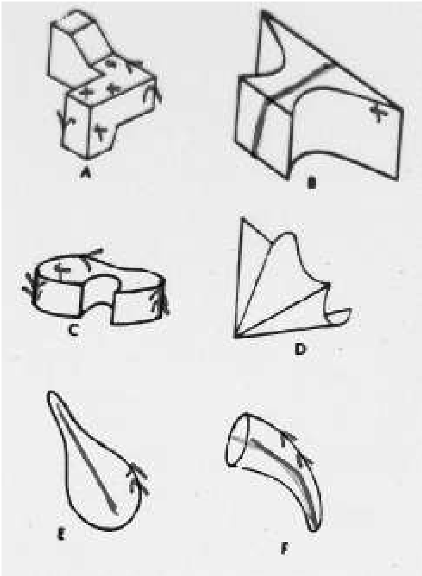

Figure 2: More sample diagrams

Line labelling: Classifying the image curves as depth or orientation discontinuities (and then further sub-classifying them).

2.4 Some sample diagrams

Line drawings should be used *qualitatively*, no quantitatively. Ref. Fig1,2.

2.5 Cues

Symmetry: Natural objects tend to show symmetry. This enables us to fill-in missing data (since we're just getting two views of the same object). Surfaces of revolution project to bilaterally symmetric figures in the image.

Rectangularity: We know that the 3 vertices of a rectangular corner must be mutually perpendicular (i.e. dot product = 0). So given that the 3 vertices are:
$\tilde{v_1} + \lambda_1 \hat{z}, \tilde{v_2} + \lambda_2 \hat{z}, \tilde{v_3} + \lambda_3 \hat{z}$

We know that:
$(\tilde{v_1} + \lambda_1 \tilde{z}).(\tilde{v_2} + \tilde{v_2} \tilde{z})$
$= \tilde{v_1}\tilde{v_2} + \lambda_1\lambda_2 = 0$
$= \cos\theta_{12} + \lambda_1\lambda_2 = 0$

$\Rightarrow$
$-\cos -\theta_{12} = \lambda_1\lambda_2$
$-\cos -\theta_{23} = \lambda_2\lambda_3$
$-\cos -\theta_{13} = \lambda_1\lambda_3$

(By multiplying) $\Rightarrow$
$(\lambda_1\lambda_2\lambda_3)^2 = -\cos\theta_{12}\cos\theta_{23}\theta_{13}$
$\Rightarrow \lambda_1\lambda_2\lambda_3 = \sqrt{-\cos\theta_{12}\cos\theta_{23}\theta_1}$
$\Rightarrow \lambda_1 = \frac{\sqrt{-\cos\theta_{12}\cos\theta_{23}\theta_1}}{-\cos\theta_{12}}$

Thus, the product of the cosines of the 3 angles created by the 3 converving vertices must be negative for the corner to be rectangular.

2.6 An Aside

Q: How can we assume rectangularity?
A: This question has been raised in various forms, but is based on the Nature vs. Nurture problem. Degerowski performed an experiment in Rhodesia/Zimbabwe where the culture has round structures, he found that corner cues did not work. But these results have been challenged.
Another experiment raised chicks with light coming up from the ground: the acted the same as the ‘normalčhickens. It was concluded that the behaviour is rooted in genetics (Nature), which makes sense, since the sunlight has been coming from above since chickens have been around. A similar phenomenon is face recognition: 15 minute old babies have demonstrated this ability as tested by preferential looking.

2.7 Occlusion

ref. Fig. 4

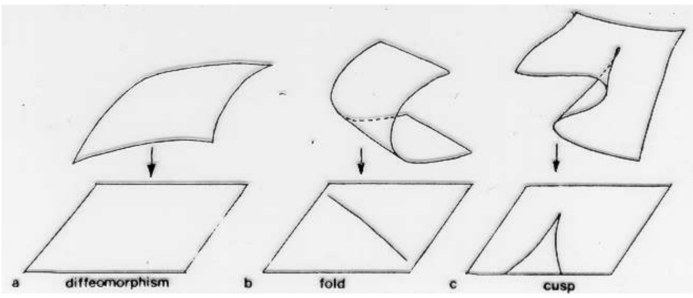

Figure 3: Junctions

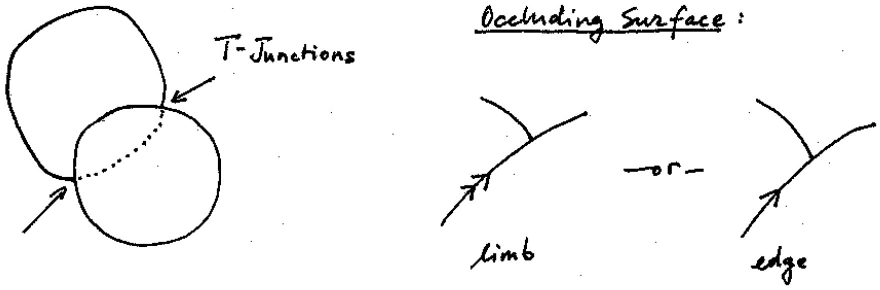

Figure 4: T-Junctions

2.8 Junctions

Junctions occur at tangent discontinuities.

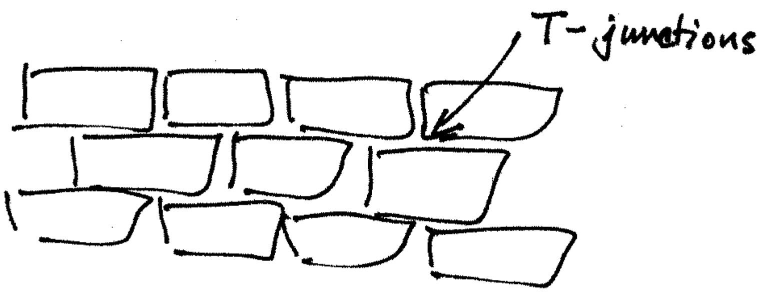

Figure 5: T-Junctions: false leads from surface marks(brick wall)