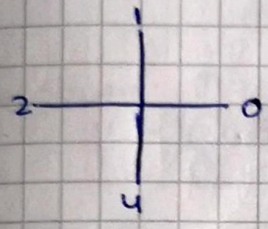
Edge extraction

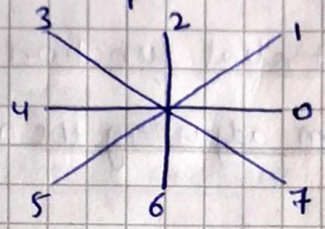
① In edge extraction, connected lines in an image are identified as boundaries of a region which is then segmented. One distinguishes b/w
edge extraction with line operators
" " " " morphological operators.

② several methods are available for processing and representation of lines. Important methods include:
(a) chain code
(b) Hough Representation
(c) Splines
(d) Active contours

(A) chain code (Freeman) → Representation of the contour using direction data.

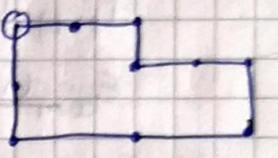


4-point



8-point

1	2	3
8	X	4
7	6	5



Advantages → compressed representation (no need to represent the whole image with coordinates)

Disadvantages → The coordinate information is not always available
→ If reflected, the coordinate value changes
→ Not rotation invariant

Solution → Normalised chain code. → ① Chain code
② circular first diff.
③ NCFD (see 1st zero, after that scan remaining them)

(B) Hough Transformation

(C) Splines → Employed for representation of connected lines and contours.
→ Relatively low no of points suffice.
→ Can be employed for completing broken lines.

(D) Active Countours → ① used mostly in image processing (medical)
② Based on minimising an "energy" functional.
③ Adapt to image properties.

Examples: Snakes: ① employed for detection of edge and boundaries of objects
② do not need line operators
③ finds also the broken lines

* An optimal snake minimises the "energy" functional.

$$\varepsilon_{snake} = \int_0^1 \varepsilon_{int}(v(s)) + \varepsilon_{ext}(v(s))\,ds$$

Internal energy - coming from the image itself.

$$E_{int} = \underbrace{\frac{1}{2} W_1(s) |V_s(s)|^2}_{\text{elasticity}} + \underbrace{\frac{1}{2} W_2(s) |V_{ss}(s)|^2}_{\text{smoothness}}$$

→ can be understood as stiffness

Eg. → If we start the contour as a circle, now easy it is to become a triangle or a rectangle.

External energy - derived from image and some corrective term.

$$E_{ext} = P_{prop_0}(V(s)) + E_{con}(V(s))$$

$P_{prop_0}(V(s))$ → scaler potential function

$E_{con}(V(s))$ → energy term adjusting the model.

* The image potential drives the contours to image characteristics such as lines and corners. It can once again be represented as weighted potential terms.

$$P_{Grid} \rightarrow W_{line} P_{line} + W_{edge} P_{edge} + W_{gap} P_{gap}$$

line potential - sensitivity. the snakes is then sensitive to lines in the image.

$$P_{line} = I(x,y)$$

depending upon the sign of the "W_{line}". the snakes are drawn to the brighter or darker areas.

Edge potential - gradients. the detection of image edges can be achieved by using the following potential

$$P_{edge} = -|\nabla I(x,y)|^2$$

if noise → $P_{edge} = -|\nabla(G_\sigma(x,y) * I(x,y))|^2$

Baloons → Extentions of snake model.

→ It can happen that the internal energy of the internal snake model is not sufficient to let the snake grow for enough to reach the potential of the image. where they can then come to a stop.

They stop before reaching the contour.

→ A "baloon force" is introduced which makes the snakes to grow

if baloon force high → we can overrun our edges in the image