

Computer Graphics & Image Processing

Paper 5 Question 5

NAD — Graphics and Image Processing

- (a) the line has two endpoints, P_1, P_2
 the rectangle has four boundaries
 $x = x_L \quad x = x_R \quad y = y_B \quad y = y_T$

- (1) check each end point against each edge to produce a four bit code

$$a = (x < x_L) \quad b = (x > x_R) \quad c = (y < y_B) \quad d = (y > y_T)$$

You get two codes: $Z_1 = abcd$ for P_1
 $Z_2 = abcd$ for P_2

- (2) If $Z_1 \wedge Z_2 \neq 0$ STOP

the line is guaranteed to be wholly outside the rectangle

If $Z_1 = Z_2 = 0$ then the clipped line is $\overline{P_1 P_2}$

Otherwise you need to clip the line by one of the edges.

- (3) If $Z_1 \neq 0$ select P_1 to clip, otherwise select P_2
 Find the first non-zero bit in Z_i and clip P_i
 against its related edge

For example, to clip P_1 against $x = x_L$

Let $P_1 = (x_1, y_1), P_2 = (x_2, y_2)$

We want to find $P_1' = (x_1', y_1')$

$x_1' = x_L$ by definition

$$y_1' = \frac{x_L - x_1}{x_2 - x_1} (y_2 - y_1) + y_1$$

Similar cases apply for the other point & the other three edges

Once you have found P_1' , you must recurse to step (1) with the new edge $\overline{P_1'P_2}$

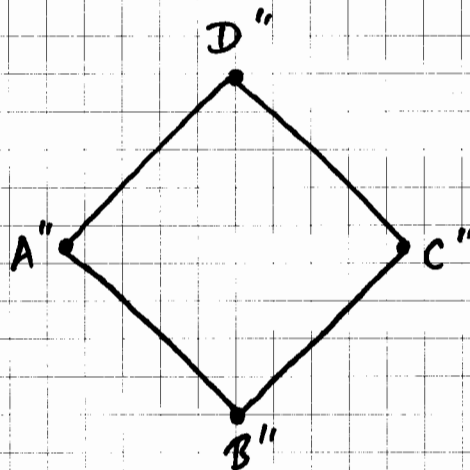
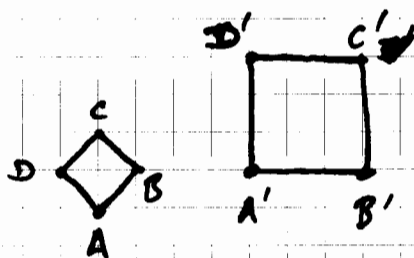
(b) Homogeneous coordinates allow us to incorporate translation into our matrix formulation of transformation. They also allow for perspective transformations

(c) $M = T \times R \times S$

$$= \begin{bmatrix} 1 & 0 & 4 \\ 0 & 1 & 1 \\ 0 & 0 & 1 \end{bmatrix} \times \begin{bmatrix} \frac{1}{\sqrt{2}} & \frac{1}{\sqrt{2}} & 0 \\ -\frac{1}{\sqrt{2}} & \frac{1}{\sqrt{2}} & 0 \\ 0 & 0 & 1 \end{bmatrix} \times \begin{bmatrix} \frac{3}{\sqrt{2}} & 0 & 0 \\ 0 & \frac{3}{\sqrt{2}} & 0 \\ 0 & 0 & 1 \end{bmatrix}$$

$$= \begin{bmatrix} \frac{3}{2} & \frac{3}{2} & 4 \\ -\frac{3}{2} & \frac{3}{2} & 1 \\ 0 & 0 & 1 \end{bmatrix}$$

(d) $A'' = MA' = \left(\frac{23}{2}, \frac{7}{2}\right)$; $B'' = MB' = (16, -8)$
 $C'' = MC' = \left(\frac{41}{2}, -\frac{7}{2}\right)$; $D'' = MD' = (16, 1)$



CONTEXT

This question tests the "2D Computer Graphics" part of the course

PRELIMINARY MARKING SCHEME

- (a) need to check both endpoints
against all four edges
coding scheme abcd
trivial reject case $z_1, z_2 \neq 0$
trivial accept case $z_1 = z_2 = 0$
need to clip one end against one edge
how to choose which end
how to choose which edge
how to calculate the new point
need to recurse

} 2	EV
	R
	A
	{ CV
} 1	NV
2	PV
<u>2</u>	10

- (b) mention translation
mention matrix representation of transformations
general clearly

1	T
	M
	✓
<u>1</u>	3

- (c) translation matrix
rotation matrix
scale matrix
correct order, either $T \times R \times S$ or $T \times S \times R$

	T
	R
	S
	✓
<u>1</u>	4

- (d) correct locations of the four corners

<u>3</u>	<u>3</u>
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