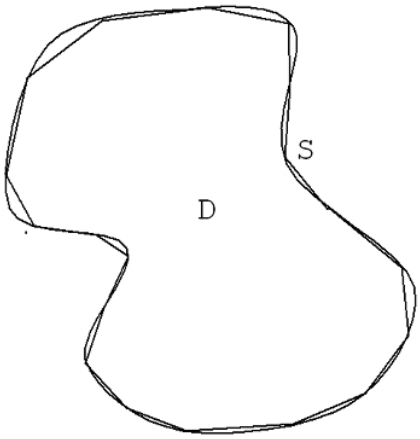
Representation of a line by flat panels

In the two-dimensional boundary element method, the simplest method for representing the boundary is by using a set of straight lines or flat panels, as illustrated in the following figure.

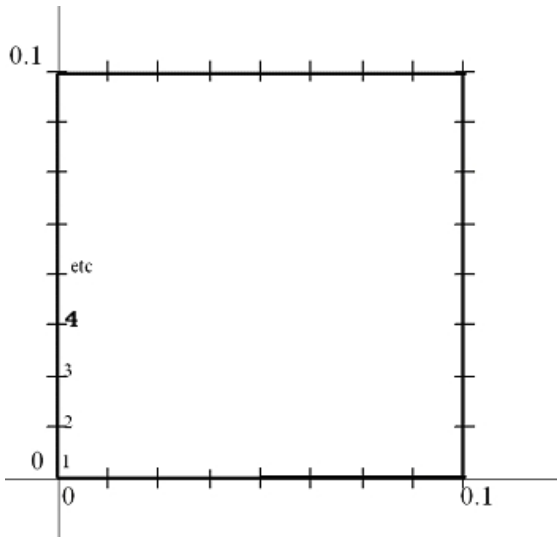


In the boundary element method for a closed boundary, we specify that the normals to the boundary are *outward*. In order to maintain this convention the two nodes that define each panel must be listed in the clockwise direction around the boundary. If consecutive nodes are passed in order to the subroutine NORM2 in GEOM2D (in Fortran[1], Excel-VBA[2] and in Matlab[3]) then the unit outward normal is returned.

If the boundary is open then one side of the line is set as 'outward' and the other 'inward'. It doesn't matter which way around the sides are labelled, as long as this is consistent for all panels.

Example: Division of a 0.1 × 0.1 square into 32 elements.

The following diagram illustrates the square with the 32 uniform panels.



[1]Fortran: GEOM2D.FOR
[2]Excel-VBA: GEOM_xlsm.pdf
[3]Matlab: GEOM_m.pdf

The boundary is represented by 32 uniform panels and also has 32 nodes. The boundary can be defined by first specifying the nodes. The boundary can then be defined by a set of panels, with each panel being defined by the two nodes at each of its ends.

The coordinates of the nodes are listed in the array '*vertex*'.

Vertices of square boundary (VERTEX)					
Index	x	y	Index	x	y
1	0.0000	0.0000	17	0.1000	0.1000
2	0.0000	0.0125	18	0.1000	0.0875
3	0.0000	0.0250	19	0.1000	0.0750
4	0.0000	0.0375	20	0.1000	0.0625
5	0.0000	0.0500	21	0.1000	0.0500
6	0.0000	0.0625	22	0.1000	0.0375
7	0.0000	0.0750	23	0.1000	0.0250
8	0.0000	0.0875	24	0.0000	0.0125
9	0.0000	0.1000	25	0.1000	0.0000
10	0.0125	0.1000	26	0.0875	0.0000
11	0.0250	0.1000	27	0.0750	0.0000
12	0.0375	0.1000	28	0.0625	0.0000
13	0.0500	0.1000	29	0.0500	0.0000
14	0.0625	0.1000	30	0.0375	0.0000
15	0.0750	0.1000	31	0.0250	0.0000
16	0.0875	0.1000	32	0.0125	0.0000

The panels that make up the boundary are defined in the array '*selv*' as follows.

Panels that constitute the square (SELV))					
Index	Vertex 1	Vertex 2	Index	Vertex 1	Vertex 2
1	1	2	17	17	18
2	2	3	18	18	19
3	3	4	19	19	20
4	4	5	20	20	21
5	5	6	21	21	22
6	6	7	22	22	23
7	7	8	23	23	24
8	8	9	24	24	25
9	9	10	25	25	26
10	10	11	26	26	27
11	11	12	27	27	28
12	12	13	28	28	29
13	13	14	29	29	30
14	14	15	30	30	31
15	15	16	31	31	32
16	16	17	32	32	1

Test problems using these boundary definition can be found on www.boundary-element-method.com for solving Laplace's equation[4], the Helmholtz Equation[5] or for acoustic problems[6].

[4] Laplace's Equation
[5] Helmholtz Equation
[6] The Boundary Element Method in Acoustics