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Explanation for "meshgen3.m"

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This is a brief explanation for "meshgen3.m". This is not official report, Please not use without using the program

These figures (Figure1,2,6,7) are results when I input following data. I will explain about procedure with this results. Following table (Table:1) is described the input data for "meshgen3.m".

Step 0

Firstly describe the demanded shape from the input data.
Bule broken line means edge of the demandes rectangle. Red broken line means extension derection. So the red line should suit element diagnal.

Valuable name	input number	
Ox	-0.01m	x position for left bottom apex of Rectangle (blue big dot on Figure 1)
Oy	-0.01m	y position for left bottom apex of Rectangle (blue big dot on Figure 1)
Length	0.02m	Length of the Rectangle
Height	0.02m	Height of the Rectangle
Element	0.001m	square-shaped element(before extension)
theta	45°	Angle between X axis and Element-diagonal
ExtensionCentrePos	[0.0 , 0.0]	Position of the Maximum extended element
MaxDiagnal	0.0018m	Diagnal length of the Maximum extended element
Eccentricity	0.98	Eccentricity of the ellipse that is used for deciding extended ratio for each elemnt (yellow points on Figure 8)

Table 1: input data

Step 1

Move the ExtensionCentrePos to origin and rotate theta dgree clockwise . But moving to origin is needless in this case because I choose origin for ExtensionCentrePos. You can easily understand that the ExtensionCentrePos will be moved to origin when you input different number of ExtensionCentrePos. That procedure changes the coordinate for make the node-relationship simply. The red line sould be fited with X axis. So the Extended Base Nodes on the extension (yellow dots on Figure8) , that will make other nodes after, move on the X axis and other nodes will keep symmetrical position about Y axis.
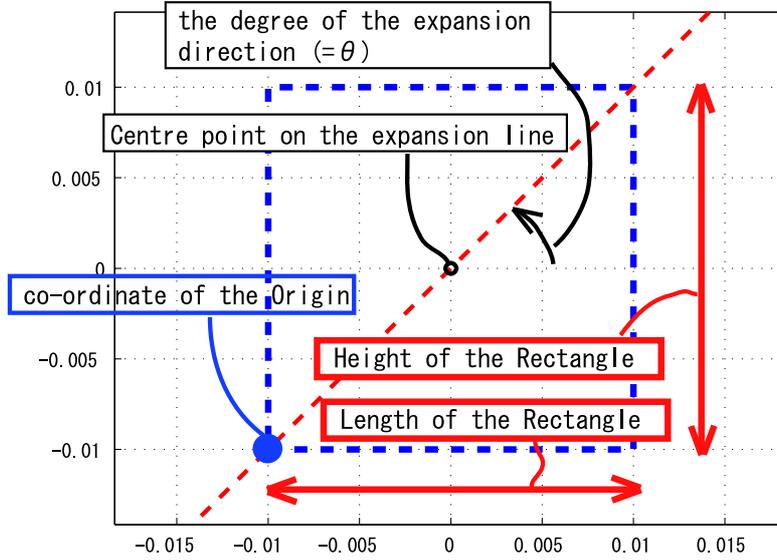
Figure 1: Figure 1 (left-top)

Step 2

Next, we have to decide the size of the net. If we choose too large net to cover the rectangle, the calculation time becomes longer and that is far from realistic situation.

In order that, we have to find the proper size of the net. To find the size of the net, we have to consider the border of the deformed(extended) net.

See Figure3, the extended net has the different length of the diagonal(Blue line).

Hence the half number of the diagonal is n and these diagonals are named $a_1, a_2, \cdots, a_n$. The nodes position on the X axis are following.

$$
(X~,~Y) = (-2\sum_{i=1}^{n} a_i~,~0), (-2\sum_{i=1}^{n-1} a_i~,~0), \cdots
$$
$$
, (-2a_1, 0), (0, 0), (2a_1, 0), \cdots
$$
$$
, (2\sum_{i=1}^{n-1} a_i~,~0), (2\sum_{i=1}^{n} a_i~,~0)
$$

By the way, thinking about the Element length, the deformed net keeps the relation between each truss. Actually, the truss that have same color in
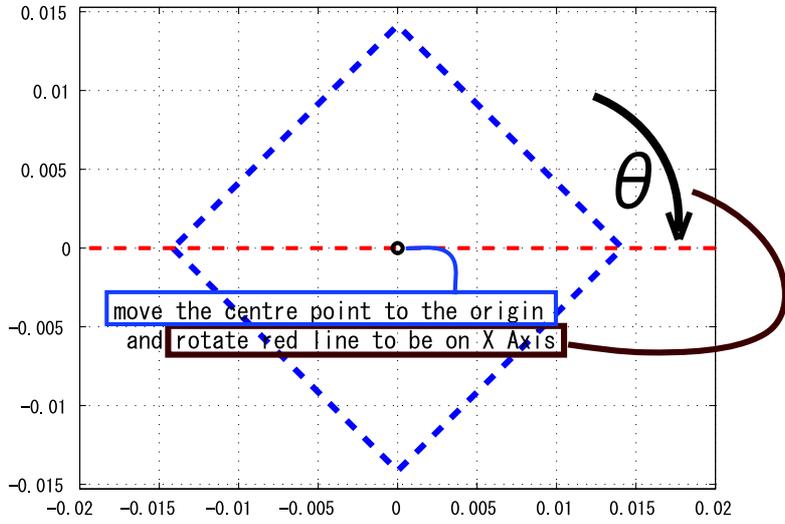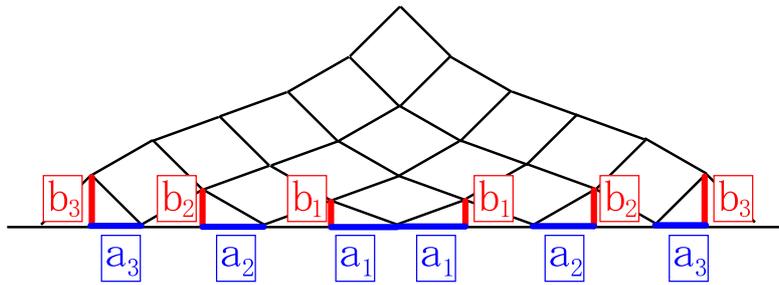
Figure 2: Figure 1 (right-top)

Figure 3: ellipse algorithm 2

Figure4 should keep parallelism. So, if we have the progression a_n, we can find the positional relation wetween all nodes (Figure 4).

Then we have to make the (decreasing) progression a_n.
To make the progression a_n, We will use a ellipse equation. Ellipse equation is following.

$$\frac{x^2}{A^2} + \frac{y^2}{C^2} = 1 \tag{1}$$

$$e = \sqrt{1 - \frac{C^2}{A^2}} \tag{2}$$

Hence,$2A$ is called major-axis, $2C$ is called minor-axis,and e is called eccentricity.
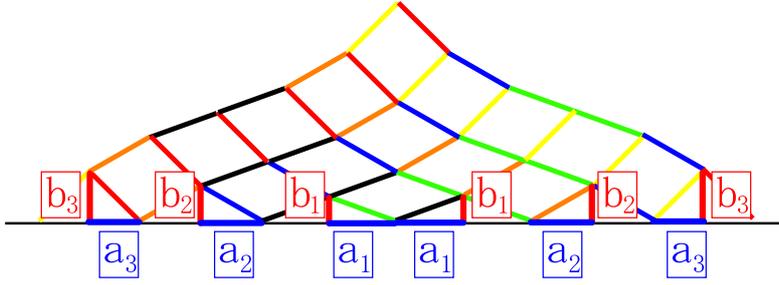See Figure 5.

Figure 4: ellipse algorithm 3

At first, put decreasing dots at even intervals(red dots on figure 5).
Then, we can calculate the x position on the ellipse curve.(bule circle on Figure 5).From eq.(1), the equation is following.

$$a_n = A\sqrt{1 - \frac{c_n{}^2}{B^2}} \tag{3}$$

$$= A\sqrt{1 - \frac{c_n{}^2}{A^2(1 - e^2)}} \tag{4}$$

If we decide A as "MaxDiagnal" in Table 1, a_n will be a decreasing progression.

Therefor, from the node that is left end of the extension line (the position is $(-2\sum_{i=1}^{n} a_i \ , \ 0)$), the border of the deformed net can be calculated.

Because the Size of the border is depend on the number of the element, check iteratively the element number that deformed net will cover the rectangle .

See Figure 6, the blue line is the border with element number $n = 3$. The green line is the border with $n = 5$. And red line is border with $n = 14$. When n reache to 14, the border covers the Rectangle for the first time.(Red line cover the bule broken line)
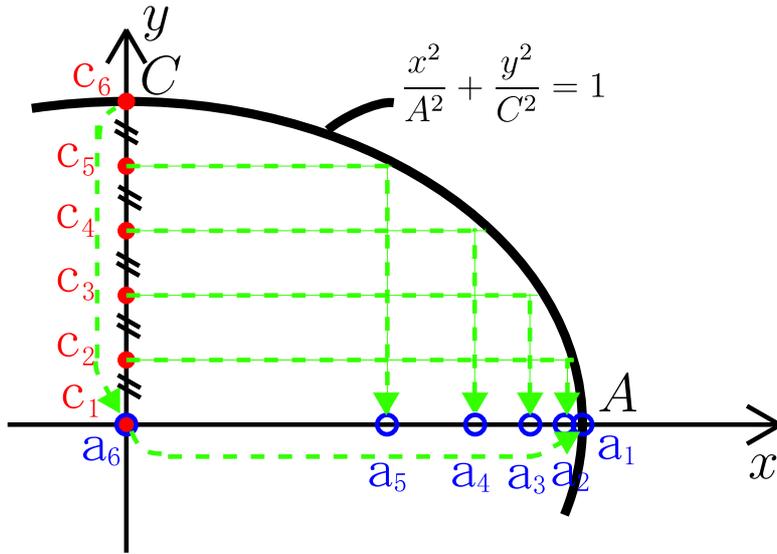
Figure 5: ellipse algorithm 1

Step 3

For the next step, we need remove the node that lie outside of the rectangle. Firstly find the node which lie outside the rectangle.(Bule area on the Figure 7) But it's not perfect for membrane-element and truss-element. Cause of some elements crossing the rectangle border, we need to remove the imperfect element.

(I choose the way that checking the each element which is connected to the outside node or not.)
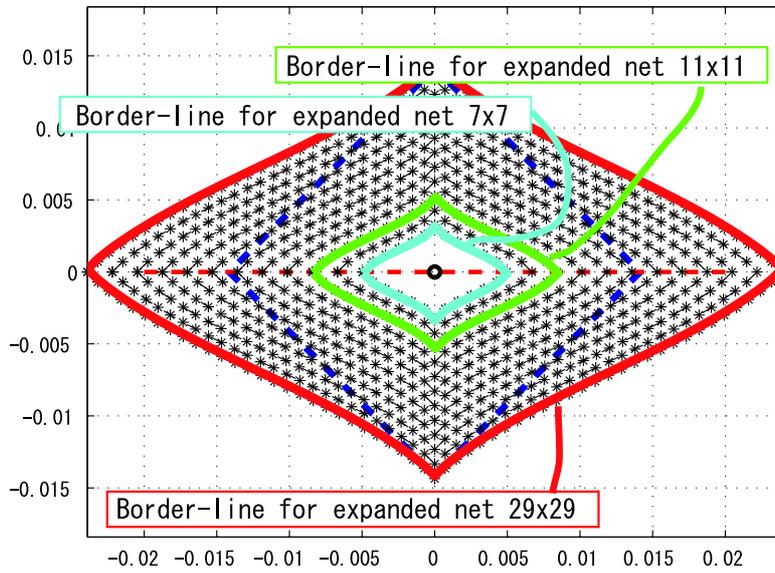
Figure 6: Figure 1 (left-bottom)

Step 4

Finally, We have to return the initial rectangle position. That is moinge origin to the ExtensionCentrePos and rotate theta dgree counterclockwise . This is the result for the demanded rectangle.(Figure 8)
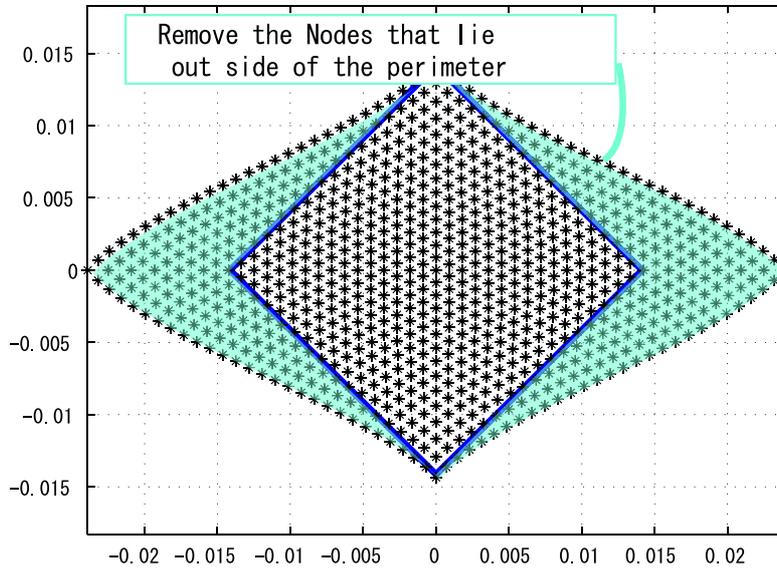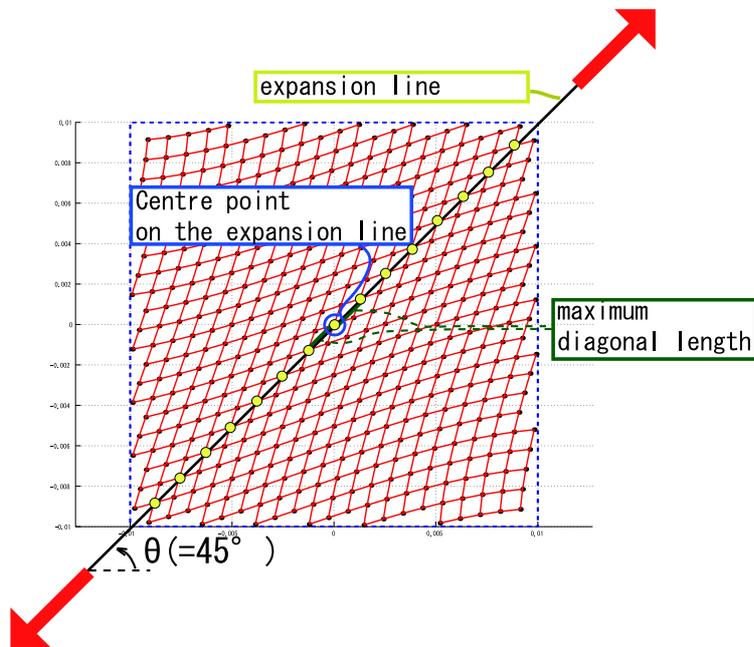
Figure 7: Figure 1 (right-bottom)

Figure 8: Figure 2:generated mesh(Rectangle)