

Modeling of Irregularly Shaped Two – Dimensional Objects

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Abstract

In this paper the description of the two - dimensional modeling program of irregularly shaped objects is given. The program is very easy to use, it works fast and has many other advantages.

Keywords: Optimal cutting of materials, Two - dimensional modeling, Packing problem.

1. Introduction

The problem of two-dimensional modeling is the first step of achieving the optimal arrangement of any irregular shape details on the surface. The applications of this optimization problem are related to the real life issues in the field of optimal cutting from any limited material, for example, wood, leather, metal or paper [1-4].

Actually there are some existing softs that can solve this issue [5], but they do not work with irregular shapes. Some of them are working with rectangles only [6,7], the others are private or very expensive.

The description of the objects usually begins with the design of digital model. For this purpose a software environment is implemented in which the two - dimensional digital models are created.

The interface of this tool is similar to already existing three-dimensional editors like AutoCAD, 3ds Max, etc. But today's existing tools are designed for three-dimension objects therefore, they contain a very huge set of unnecessary tools and are hard to use. Meanwhile the approach of creating a two-dimensional editor will simplify and speed up the process multiple times, and will need less productive capacity.

The main principle of making an irregular shape object is manipulation with simple geometrical shapes, because every complex shape consists of more or less amount of simple shapes. These shapes can be designed manually, by mouse and with coordinates.

The paper is organized as follows. The description of simple geometrical shapes modeling is given in the second section. How to manipulate with the existing shapes is given in section three. Making of any shapes from simple ones is described in section four.

2. Modeling of Simple Geometrical Shapes

In our program there are corresponding tools for creating simple shapes, the main shapes supported by the soft are:

1. Rectangle
2. Ellipse
3. Polyline

They are automatically including the square, circle and other shapes. For creating complex shapes from simple ones they have to be transformed, rotated and changed in dimensions.

When soft works only with these simple shapes, it needs only to remove the existed shape and create some new shape with new given properties. But when it needs to work with complex shapes the program has to remember all the simple shapes that the complex shape is made of, and after transformation recreate all simple shapes, then transform them with the given way and then again create a complex shape from them. Each of the above-mentioned elements has specified tools. It is made for even more flexibility of the soft, and the modeling of the shapes can be done without any limitations and deep knowledge of modeling. Here is the list of the tools and their working modes:

1. Rectangle

- i) *To give the diagonal points*: it can be done by mouse or by giving x and y coordinates of that points in the specified fields, or with combined way, by giving the x point by mouse and y by coordinates.
- ii) *To give a one diagonal point with width and length of the rectangle*: it can be done by the same three ways.

2. Ellipse

- i) *To give the diagonal points of the circumscribed rectangle*: this is very similar to the first mode of the rectangle.
- ii) In the special case *to give the circle*: it can be done by giving the center and r radius, it also can be done by multiple ways, by mouse and by coordinates.

3. Polyline

- i) *To give the coordinates of the corner points*: after giving the last point the soft will automatically close the chain by linking the first and the last points.

4. Contour

- i) It is the special case of the polyline with very small distances, it has been included for easier work with *irregular lines and curves*: it is convenient to give by mouse, it continuously takes the points and creates a very deep cornered polyline. If it is not necessary to achieve a very high level of accuracy, this tool can be used (see image 1).

5. Point

- i) It is not an independent object, but it will help to use all the above described tools.

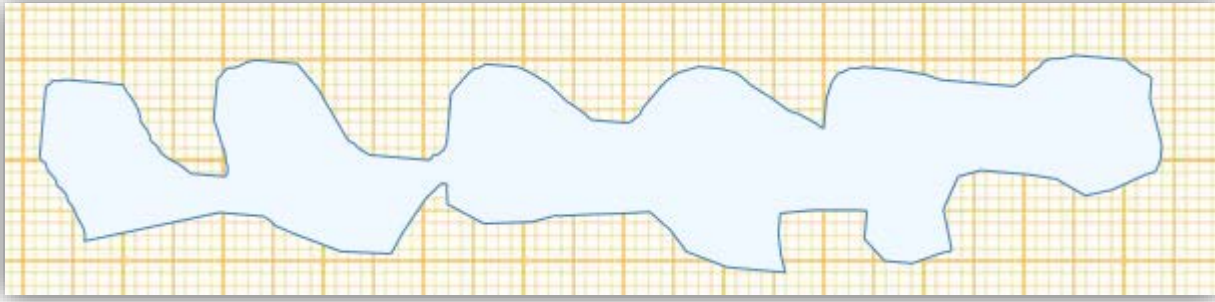


Fig. 1. Object created by the program.

3. Manipulating with Existing Shapes

The **movement** of the objects is realized by the geometric center. The coordinates of that point can be calculated with the help of the circumscribed rectangle:

$$x = TopLeft.x + Width/2, \quad (1)$$

$$y = TopLeft.y + Height/2,$$

where TopLeft.x and TopLeft.y are x and y coordinates of the top left corner point of the rectangle. After movement the coordinates of the new point will be

$$x' = x + d_x, \quad (2)$$

$$y' = y + d_y,$$

where x' and y' are new coordinates of the point and d_x and d_y are the movement distance.

The **rotation** of the objects can be realized by axis or by the center point or by any given point. The rotation angle can be given either by the mouse wheel or by the given quantity. The new coordinates are calculated by the following formulas:

$$x' = x + \tan(A) - (y - ck_x), \quad (3)$$

$$y' = y + \tan(A) - (x - ck_y),$$

where A is the rotation angle, ck_x and ck_y are x and y coordinates of the central point.

It is possible also to make **size modifications**. For that again the coordinates of the central point are needed, the transformation will be done by the following formulas:

$$x' = s_x * x + (cs_x - s_x * cs_x), \quad (4)$$

$$y' = s_y * y + (cs_y - s_y * cs_y),$$

where s_x and s_y are horizontal and vertical zoom coefficients and cs_x and cs_y are coordinates of central point.

4. Making Complex Shapes from Simple Ones

Of course, the contour tool can be used for creating irregular shapes but in the more precise way it can be made from simple shapes. There are 4 kinds of combination tools (see Fig. 2):

1. **Union** - creates an object that contains all the points of component objects,
2. **Intersect** - creates an object, that contains only the common points of component objects,
3. **Xor** - creates an object, that contains points, that belong only to one of objects,
4. **Exclude** - creates an object that contains all the point that belong to the first object but not to the second one.

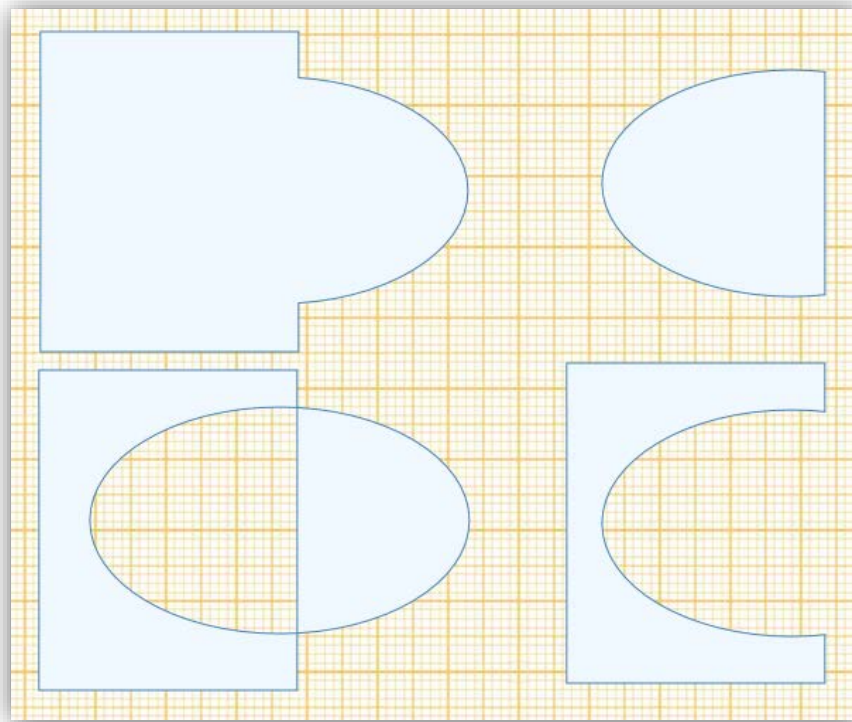


Fig. 2. All tools in action.

The last two tools work only for two objects, but for multiple objects the recursive approach can be used.

To select an object to be manipulated, there are three conditions:

1. The selection area will be completely in the object (see Fig. 3).
2. The object will be completely in the selection area (see Fig. 4).
3. The selected area must be crossed with the object (see Fig. 5).

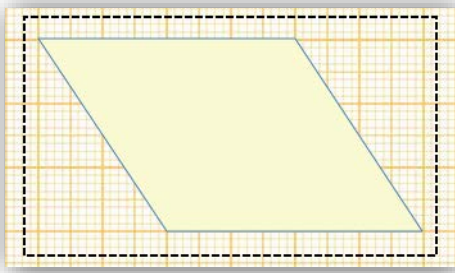


Fig. 3

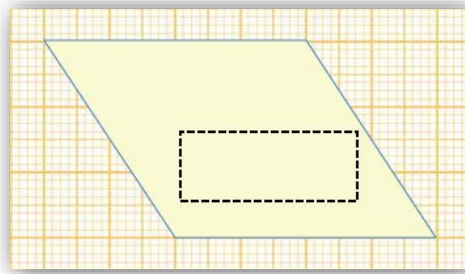


Fig. 4

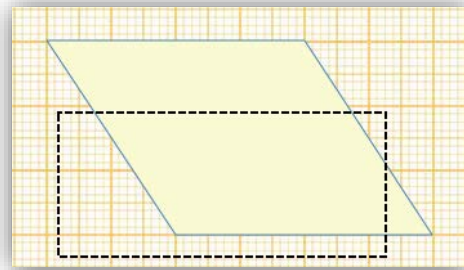


Fig. 5

An example of selection of multiple objects is given in Fig. 6.

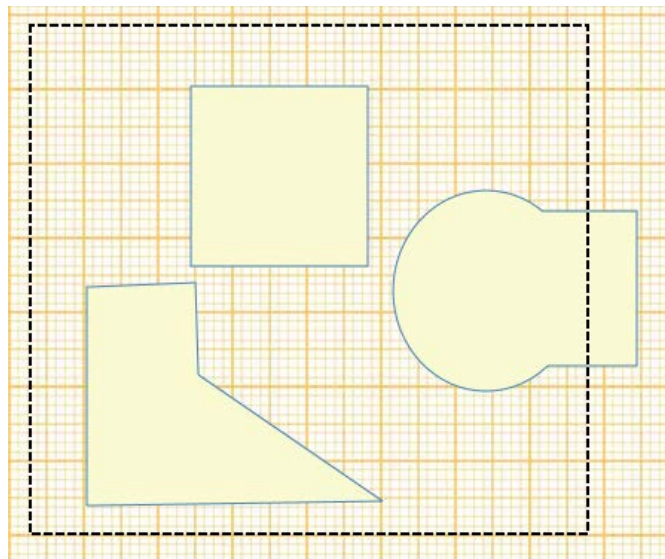


Fig. 6. Example of selection of multiple objects.

5. Conclusion

We have implemented a program which is modeling two - dimensional irregularly shaped objects. It includes tools for creating simple geometrical objects, for manipulating with them and for creating complex shapes.

References

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Կամայական ուրվագծով երկչափ օբյեկտների մոդելավորում

Ա. Քեյան

Ամփոփում

Աշխատանքում նկարագրված է կամայական ուրվագծով օբյեկտների երկչափ մոդելավորման մշակված ծրագիրը: Ծրագիրը շատ հեշտ է օգտագործել, այն աշխատում է արագ և ունի մի շարք այլ առավելություններ: Այն ներառում է գործիքներ պարզ երկրաչափական օբյեկտների ստեղծման համար, դրանց հետ տարբեր գործողություններ կատարելու համար, ինչպես նաև բարդ ուրվագծեր ստեղծելու համար:

Моделирование двумерных объектов произвольного очертания

А. Кеян

Аннотация

В данной статье приведено описание программы двух - мерного моделирования объектов неправильной формы. Программа очень проста в использовании, работает быстро и имеет много других преимуществ. Она включает в себя инструменты для создания простых геометрических объектов, для манипуляции с ними и для создания сложных форм.