Computer Aided Drawing System Development of Corrugated Box with Auto CAD

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Abstract. Corrugated box is one of the most widely used packaging products. Currently drawing and modelling corrugated box in AutoCAD system is complicated, it needs to consult the national standard size and draw step-by-step. Based on the establishment of Access database, we use Visual Basic to develop corrugated box drawing system on the AutoCAD platform. The corrugated box drawing system development has the characteristics of parameter standard and using easily. Users only need to select the box type in the main interface of the software and input the important parameters, the two-dimensional expansion diagram and three-dimensional model can be quickly obtained, which greatly improves the efficiency of corrugated box drawing, reduces labour and production cost.

1. Introduction

Corrugated cardboard box is a packaging transport carton which is made of corrugated cardboard, it has light, strong, commodity protection, convenient storage and transportation characteristics, it is also a good packaging materials, and it can instead paper and plastic, so the paper material has the good development prospect because of the recycle characteristic and green environmental protection, therefore obtained the widespread application [1]. At present, the drawing of corrugated box based on the AutoCAD is complicated and inefficient. Once the parameter is entered incorrectly or changed, it needs to be redrawn. The Access database is established in the drawing system, and the drawing software based on AutoCAD is developed by Visual Basic. By inputting the important parameters of the corrugated box in the main interface of the software, the users can quickly generate the two-dimensional expansion diagram and three-dimensional model that they need, which can improve the drawing efficiency and reduce the labor and production cost. And it is convenient to use the
standard parameter.

2. National Standard and classification of corrugated box.

2.1 National standards for corrugated boxes

According to the National Standard GBT6543-2008 for corrugated boxes, the classification of box type, quality limitation of contents and comprehensive size limitation are shown in Table 1. Among them, the overall dimension of corrugated box is the sum of the length, width and height. Table 2 shows the two-dimensional expanded structure sketch in drawing which should conform to the requirements of GB / T12986 -- 1991. Table 3 is the dimension ratio of length L, width H and height B, which are commonly used to describe the structure shape of corrugated box.

Table 1. Classification of corrugated boxes in China.

| Species                  | Maximum mass of contents /kg | Maximum overall dimensions /mm |
|--------------------------|-----------------------------|-------------------------------|
| Single corrugated box    | 5                           | 700                           |
|                          | 10                          | 1000                          |
|                          | 20                          | 1400                          |
|                          | 30                          | 1750                          |
|                          | 40                          | 2000                          |
| Double corrugated box    | 15                          | 1000                          |
|                          | 20                          | 1400                          |
|                          | 30                          | 1750                          |
|                          | 40                          | 2000                          |
|                          | 55                          | 2500                          |

Table 2. Line symbol specification

| Line name                  | Code Name | Line drawing | Line content                        |
|----------------------------|-----------|--------------|-------------------------------------|
| Single solid line          | CL        |              | CONTOUR tangent                     |
| Double solid line          | SC        |              | Slotted line                         |
| Single dashed line         | CI        |              | Infolding indentation line           |
| Double dashed line         | DS        |              | Fold 180 double indentation line     |
| Dotted line                | CO        |              | Outer fold indentation line          |
| Two DOTS and a dash        | SO        |              | Outer fold cut line                  |
| Three DOTS and a dash      | SI        |              | Clearance cut indentation line       |
Table 3. Parameter ratio of corrugated box

| Corrugated box parameter | Corrugated box dimension ratio |
|--------------------------|-------------------------------|
| Length: Width            | L:H≤2.5:1                     |
| Height: width            | 0.15:1≤B:H≤2:1                |

2.2 Corrugated box type

There are many types of corrugated boxes, due to different classification angle, classification is also different. According to the classification of corrugated box, corrugated box can be divided into 6 types: slotting type, nested type, folding type, slide closure type, fixing type and automatic type. Among them, slotting type, folding type, sliding cover type are used more widely. The concept and characteristics of the six types of boxes are shown in Table 4.

Table 4. Corrugated box type.

| Box Type | Concepts and characteristics |
|----------|------------------------------|
| 02       | 02 Box type also named slotted carton. As the most common box, 02 Box type is made of a piece of corrugated cardboard, it through cross cutting, indentation, sticking box or nailing box made. 02 Box-type swing cover without independent separation, usually by nailing or bonding joints. The molding method is mainly manual (M), automatic (A), manual or automatic (M/A), manual and automatic (M+A). |
| 03       | 03 Box type also named nested-type cartons, the case cover and the bottom of the box can separate, the case cover can cover all or part of the box, it is suitable for loading and unloading difficulties of large items. |
| 04       | 04 Box type, also named folding carton, it is made of a piece of corrugated cardboard through cross cutting, indentation. 04 Box type bottom plate can be extended into box body plate and cover plate, so it is not need nail box. 04 Box type is widely used in supermarkets and other places. |
| 05       | 05 Box type also named the sliding closure type carton, is composed of several pieces of corrugated to different inner and outer box, clapboard and frame. The structure of 05 Box type is similar to the drawer box. 05 Box type is more complicated and time-consuming, but it is more material-saving than other boxes. 05 Box type is widely used for inner packing of middle and low grade goods. |
| 06       | 06 Box type is also called fixed-type carton, which is made of two or more separate end plate and box combination nail box, before using the nail box need to handle so it is more time-consuming. As the bottom of the box is a whole, 06 box is mainly used for packing large volume and fragile goods, it is easy to move. |
| 07       | 07 Box type also called automatic pre-adhesive carton, it is made of single-page cardboard cross cutting, indentation. 07 Box transportation is flat, it has the characteristics of low transportation cost, simple molding, automatically locked and available. |
3. Software Development Platform and development tool selection

AutoCAD is a widely used secondary development drawing platform, covering a wide area and is used by many users, it has perfect graphic plotting function and powerful graphics editing function, can be used in a variety of ways for secondary development, it support multiple operating platforms. The secondary development of AutoCAD forms the object intelligent and integrated design through the restriction of the object structure description, the design method and the design specification into a collectivity, and passes to the basic tools of AutoCAD computer-aided design. In order to improve and perfect the function of the software, AutoCAD develops the software on the basis of the existing software, making it more meet the needs of the users. The secondary development can improve the design quality and efficiency, and give full play to the value of the basic software. AutoCAD offers several applications programming interface that can be used to control graphics and databases [2], making them easier to develop.

Visual Basic is one of the main development tools of Windows system. Its visibility and event-driven properties simplify the programming for Windows and make it easy for users to use. Visual Basic is an object-oriented Visual programming tool. It has simple syntax, powerful function, convenient debugging and openness characteristics. If any parameters are changed, it will be convenient to change.

4. Parametric development of corrugated box drawing system

The basic difference between parametric design system and traditional CAD system is that this kind of system can not only preserve the geometric and topological information of graphics, but also express and deal with various constraint relations of geometric elements [3]. The drawing and modeling of corrugated box strictly according to the national standard. Different box size and specifications are different. It is the key to obtain data from other box by several main parameters and modeling successfully. The external database is built according to the box national standard, which can avoid errors caused by manual inputting of parameters, reduce the time to consult the national standard data for modeling, save time and labor power, if the national standard parameters are changed, the external database can be modified to update the parametric library to meet the requirements of the corrugated box parametric library system.

5. The basic flow and concrete steps of developing corrugated box drawing system based on AutoCAD

Design of man-machine interface of corrugated box is based on AutoCAD and VB. The development interface of the main interface has two functions: The selection of carton type and the selection of planar three-dimensional development. Click the drop-down arrow of the combo box to select the corresponding carton type. In the same time, click on the corresponding two-dimensional and three-dimensional design button to enter the corresponding requirements interface for the next design. Figure 1 is the corrugated box development system software interface, figure 2 is corrugated box drawing system development flow chart that based on the AutoCAD platform.
Figure 1. Sketch map of the main interface

Figure 2. The basic flow of developing corrugated box parametric library
The author slotted 0217 box as an example, 0217 box called portable corrugated box. The box can be sealed by itself, without the need for staples, adhesives or other forms of bonding. The basic steps are as follows:

(1) Setting up the database. The data structure of database can connect the data and face the whole system, the data share and independence is high, the redundancy is low, and the development of the whole drawing software is more convenient. In order to facilitate users to choose the parameters of corrugated box, we establish the corresponding database according to the national standards to facilitate changes in the relevant parameters, conducive to the establishment of entities.

(2) Using VB to edit the 2D expansion diagram of corrugated box, and find the relevant data to determine the design steps. Since the top and middle of the 0217 box are symmetrical, one half can be drawn and the other half can be copied. But the lower rocker cover is different from the upper rocker cover and the middle, the structure is more complex, need to step-by-step drawing to determine the location of the bending line. The final 2D expansion of box 0217 is shown in figure 3.

(3) The top of the development interface of the sub-interface is the type of the box, the left side is the two-dimensional expansion diagram of the box, the single dotted line represents the bending line inward; the dotted line represents the bending line outward. On the right can input length, width, and height parameter, as shown in figure 4.

(4) The program edit of three-dimensional modeling of corrugated box. The 0217 box is modeled according to four kinds of AutoCAD secondary development drawing sentences, such as multi-segment line drawing, area drawing, stretch setting and entity setting. At the same time, VB is used to set up man-machine interactive sub-window, and four kinds of three-dimensional view angles...
are set up, such as southwest axis, southeast axis, northeast axis and northwest axis, as shown in figure 5.

Parameter input procedures include the selection of three-dimensional perspective and length, width and height parameter. The users input parameters will automatically load and obtain the corresponding size parameters in the Excel database, while drawing the closed multi-segment line in the development program, combining VB statements for surface area drawing and entity stretching and entity rotation, finally finishing the program, adding the corresponding VB auxiliary program, drawing 0217 box corrugated box three-dimension, the specific effect as shown in figure 6.

(5) The database will be connected with the drawing program of VB, and the corresponding two-dimensional development drawing and three-dimensional modeling drawing can be automatically generated after inputting length, width and height.

(6) Debugging program, loading the menu and running the program. Build required after successful run. EXE file to complete the development of parametric drawing system.

6. Conclusion

Based on the drawing software AutoCAD which is widely used at present, the corrugated box database is established according to the national standard, and the corrugated box drawing system
based on AutoCAD is developed by using VB as the second development tool. By selecting the box type and inputting the three main parameters of length, width and height, the users can quickly obtain the 2D expansion drawing and 3D model of the box type, which greatly improves the drawing efficiency.

7. Acknowledgments

This work was financially supported by 2019 Shanghai university student innovation and Entrepreneurship Project (s201910264050).

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References

[1] Fei Wang, Jun Mu. Research on the parameterization of corrugated box expansion drawing based on Solid Edge. Packaging engineering, 2014, 35 (21), 35-41.

[2] Maoyong Chen, Zuqin Huang. Quick drawing mode of Hull Structure Drawing based on secondary development of AUTOCAD. Ship, 2019, 3004, 36-42.

[3] Shuang Wang, Yuehong Dai. Data Structure Design of corrugated box CAD system based on parametric technology. Mechanical, 2000(s1), 141.