Development and Implementation of the Gear Design Parameters Automatic Generation System Based on VB

Shuping Long

Department of Mechatronics in Heyuan Polytechnic, Heyuan City, Guangdong Province,

Postal Code: 517000

Email: longshupin@sina.com

Keyword: gear design; gear parameter; VB6.0

Abstract: The gear design process involves many calculation parameters and big computational effort, which are inefficient and error-prone. In such cases, the software based on VB6.0 was developed, which can automatically operate the gear parameters and generate the result data. Software interface is simple, easy to use, and can accurately measure parameters fast and efficiently, which greatly improves the working efficiency and is significant in the development of advanced methods of gear design.

Introduction

Gear drive has many advantages, for instance, the drive ratio is accurate, the available drive ratio, the circular velocity and the transmitted power range are all big, the transmission efficiency is high, the service life is long, the structure is compact, the work is reliable, and so on. Therefore, the size transmission is one of the most widely used mechanical transmission forms in all kinds of machines. However, since the structural demand on the gear drive is higher, many parameters are involved in the process of gear drive design, and the parameter calculation is complicated, there is much work to do.

At present, the gear design software can be divided into two kinds: One kind is the major design software, such as Solidworks, UG, and etc., which are mainly focused on three-dimensional structural design. And the advantage is that they can be developed for the second time according to needs, while the disadvantage is that secondary development requires higher software application ability for designers. The other kind is the software specifically developed for gear design by all kinds of software companies. The advantage is that they can do more accurate and comprehensive parameter calculation and design for gear design, while the disadvantage is that the application is single, and the cost performance is low.

VB 6.0 (which is Visual Basic 6.0) is a common programming development language, which can let programmers develop various kinds of application programs fast and efficiently. It has such characteristics: interfacial design visualization, object-oriented programming, event-driven programming mechanism, a structured programming language, a powerful ability of database access and strong openness.

The gear design parameters automatic generation software was developed under VB 6.0. The programmers only have to enter the essential data of gear into the software, they can directly get a series of required gear design parameters, which can improve the efficiency of gear design and the accuracy of gear parameters design.

According to the software realization function and the software characteristic, the software development process is shown in Fig.1.

The Data Acquisition of Gear Design Parameters

Take the transmission design of straight spur gear as an example. First, the gear drive had to be designed according to the transmission requirements, to confirm the number of teeth, the modulus, the pressure angle, the helix angle, the centre distance, the accuracy class, the tooth width, and so on. Many parameters were involved in the gear drive design, which are shown in Fig.2. In the design process, programmers had to calculate each of the parameters one by one according to the computational formula, in the meanwhile, they had to carry out various accuracy computations according to the accuracy requirement, which had a large amount of work and was error-prone.

Fig.1 Software Development Process

Fig.2 Gear Design Diagram Example

After collecting the general parameters involved in the gear design and arranging the parameter calculation formulas, we can get the parameters and their expressions listed in Table 1.

Table 1 Gear Design Parameters and Expressions

Designation	Code	Parameter Equation	Designation	Code	Parameter Equation
Number of Teeth	Z	Select Design Time	Transverse Contact Ratio	e_a	$e_a = [z_1(tga_{a1} - tga) + z_2(tga_{a2} - tga)] / 2p$
Modulus	m	Decide Physical Design	Axial Contact Ratio	e_b	$e_b = b \sin_b / pm_n$
Pressure Angle	α	Evaluate by Standard	Total Contact Ratio	e_g	$e_g = e_a + e_b$
Helix Angle	β	Decide by Tooth Profile	Sliding Ratio	h	$h_1 = \frac{\tan a_{n2} - \tan a_w}{\left(1 + \frac{z_1}{z_2}\right) \tan a_w - \tan a_{n2}} \times \left(\frac{u+1}{u}\right)$ $h_2 = \frac{\tan a_{n1} - \tan a_w}{\left(1 + \frac{z_1}{z_2}\right) \tan a_w - \tan a_{n1}} \times (u+1)$
Addendum Coefficient	h_a^*	Take Standard Values	Tooth Thickness at Reference Line	s	$s = mz \sin \frac{p}{2z}$
Tooth Dedendum	c^*	Take Standard Values	Tooth Thickness at Addendum Circle	s_a	$s_a = d_a \left(\frac{p + 4x \tan a}{2z} + inva - inva_a \right)$
.....					

The Design for the Gear Design Parameters Automatic Generation System

The program was developed under VB6.0, and the design flow is as follows:

(1) The Design Process

The target of the gear design parameters automatic generation system is to enter the basic parameters of gear design under a friendly interface, to operate automatically according to the input data and to get the required various parameters. The brief process is that: start the software authenticate the authority → input the basic parameters of gear design →

click on the button for data automatic calculation → the system outputs the result.

(2) Establish the VB Project and User Interface

Established a VB project as required, created the user interface of the gear design parameters automatic generation system software in the program, and created the required control button on the user interface. The controls established on the software interface as required were: 59 labels, which defined the software interface of the parameters that needed to be input or measured by the software respectively; 101 textboxes, which defined the interface of the parameters that needed to be

calculated by the software respectively; 3 command buttons, which were set respectively for running the software as the operations of “calculation, reference calculation, eliminating contents” and so on.

(3) Write the VB Program Code

Write the VB program code based on the functional requirements of the software, as follows:

Write the registration code

```
Private Declare Function GetVolumeInformation _
    Lib "kernel32" Alias "GetVolumeInformationA" _
    .....
    GetVolumeSerialNumber = Hex$(lpVolumeSerialNumber)
End Function
```

Write the procedure code

Based on the gear calculating parameter equations and the standard parameters, we wrote the procedure code of the variables which had expressions; we chose the assignment of some numerical values which needed to refer to the national standard. Since the procedure code involves many contents, we won't describe them one by one here, and its reduced program is shown as follows:

```
Private Sub Command1_Click()
    Dim z1 As Double, z2 As Double, mn As Double, an As Double, b As Double      'set the
data type
    Dim ha As Double, c As Double, a As Double, q As Double, l As Double
    pi = 3.14159265358979                'pi
    z1 = Val(Text25.Text)
    z2 = Val(Text26.Text)
    mn = Val(Text27.Text)
    an = Val(Text28.Text) * pi / 180      'the arc pressure angle
    b = Val(Text29.Text) * pi / 180      'the arc helix angle
    ha = Val(Combo3.Text)
    c = Val(Combo4.Text)
    a = Val(Text32.Text)                  'the actual centre distance
    .....
End If
    zcb = Int(zcb * 10000 / 1.0086) / 10000
    SaveSetting appname:="this", section:="wcf", Key:="aa", setting:=zcb
End Sub
```

(4) Run, Debug the Program and Compiled Output

We debugged the written program in order to conform to the software design requirements. And in order to run the program as an application program under Windows, we compiled the project and converted it into the executable file (.EXE) for outputting and saving.

Function Realization of the Gear Design Parameters Automatic Generation System

(1) Log-in

Double clicked the VB to generate the application software program which can automatically generate the gear design parameters, and the password prompt was displayed, as shown in the Fig. 3. Then entered the programming system password and logged-in.

(2) Measure and calculate the data

After entering the interface, we entered the essential data of gear design, clicked the computed push-button, and the system measured and calculated the relevant gear design parameters automatically, as shown in the Fig. 4. The relevant original data of gear in the legend were: $z_1 = 21$,

$$z_2 = 87, \quad m_n = 2.5, \quad a_n = 20^0, \quad b = 10^0, \quad h_a^* = 1.2,$$

$$c^* = 0.25, \quad a = 140, \quad b = 60.$$

(3) Compare and verify the data

We compared the measured and calculated data of the system with those of manual work, and the result was consistent, which verified the measurement and calculation accuracy of the system.

Fig. 3 Password Input Interface

The Gear Design Parameters Automatic Generation System

Parameter Input

	Calculate	Reference
Z1	21	
Z2	87	
Mn	2.5	
α_n	20	
β	10	
ha*	1.2	1.2
C*	0.25	0.25
a	140	
Q	8	
B	60	

Calculate

Reference Calculation

☐ Enter the tip diameter
☐ Enter Tooth thickness deviation

Clear

Whole Depth		
Modification Coefficient		
Transverse Contact Ratio		
Axial Direction Contact Ratio		
Total Contact Ratio		
Sliding Ratio		
Tooth Thickness at Reference Line		
Cumulative Gross Tolerance of Pitch	53	70
Single-tooth Limit Variation	17	18
Gross Tolerance of Tooth Profile	22	25
Gross Tolerance of Helical Line	28	29
Run-out Tolerance of Gear Ring	43	56
Cumulative Gross Tolerance of Pitch	61	75
Composite Tolerance of One Tooth Radial Direction	19	19

Data Output

	Driving Gear 1	Driven Gear 2
The Minimum Side Clearance	.137	
The Maximum Side Clearance	.314	
Modification Coefficient	1.2519	0
Reference Diameter	53.31	220.85
Tip Diameter	65.145	226.431
Input the Tip Diameter	65.145	226.431
Root Diameter	52.319	213.605
Base Circle Diameter	50.004	207.16
Base Circle Helix Angle	9.3913	
Start of Profile Diameter	53.616	218.349
Whole Depth	6.413	6.413
Tooth Addendum	5.917	2.788
Tooth Dedendum	.495	3.625
Transverse Contact Ratio	1.498	
Axial Direction Contact Ratio	1.327	
Total Contact Ratio	2.824	
Sliding Ratio	.141	1.507
Tooth Thickness at Reference Line	6.025	3.927
Upper Variation	-.073	-.073
Lower Variation	-.148	-.148
Tooth Thickness at Addendum Circle	-.352	1.767
Spanned Tooth Count	5	11
Common Normal Length	36.12	80.676
Upper Variation	-.068	-.068
Lower Variation	-.139	-.175
Length Bar Diameter	4.33	
Dimension over two Balls in Same Plane	63.647	226.967
Upper Variation	-.128	-.189
Lower Variation	-.259	-.484

Fig. 4 Automatic Measurement Software Interface Based on Conditions

The Innovation and Advantage of the Gear Design Parameters Automatic Generation System Based on VB

The gear design parameters automatic generation system based on VB, comparing with various kinds of software at present, has the following innovation and advantages:

(1) The interface is friendly, and the operability is high

The system operation interface is simple. In the operation, if the parameters are entered based on the interface prompt directly and the "calculation" button on the interface is clicked, the required parameters will generate automatically, which is easy and convenient to operate.

(2) The operation accuracy is high, and the reliability is good

The system was designed and developed based on the VB program, whose operational formula of parameter was defined and written in accordance with the standard formula. After analyzing the test results, we found out that the operation accuracy of the software is high, and the reliability is good.

(3) There is no need to install, and it is easy to operate

The software is an executable program with the extension of “.exe”, and there is no need to install. The software can operate automatically once you click the program.

(4) Based on VB with a good applicability

Since the parameters automatic generation system was written based on the VB program, the operators only have to possess the VB programming knowledge can they modify the program according to actual demands while using it. Therefore, the applicability of the software is good.

(5) The cost performance is high

At present, the royalty of the major design software and the dedicated gear software, which are being used in the market, is high. In the meanwhile, if the major software is used in the module of gear design, it needs to be reengineered, which will cost a lot. However, this software has a low upfront costs and a low cost of maintenance and function upgrade, which has a high cost performance.

Conclusion

The gear design parameters automatic generation system was run in the design department of the company and had a good effect. The software has a fast speed of measurement and calculation and generates accurate data, which can greatly reduce the workload of designers and improve the efficiency of gear design. Therefore, the software has a good application prospect.

Author: Shuping Long (July, 1982), female, Lianyuan City in Hunan province, lecturer, Master degree

Major Research Direction:

Machine design, mechatronics control, the electrical control technology of numerical control machine tool, the adjustment of the numerical control machine tool, CAD/CAM technology

Telephone: 13750253244 Email: longshupin@sina.com

Address: Sainawan Garden 68-B, Huangsha Avenue, Yuancheng District, Heyuan City, Guangdong Province

Postal Code: 517000

References:

- [1] Xiaolu Zhu: *The Design Handbook of Gear Drive* (In Chinese) [M]. Beijing: Chemical Industry Press, 2010.3
- [2] Likun Yan, Zhaoyun Wu and Lihui Wu: *Design of Automatic Generating Software of AutoCAD Part-List Based on VB* (In Chinese) [J]. Machinery Design and Manufacture, 2013(4):11-13
- [3] Lina Han: *The Parametric Design of Gate Parts Based on VBA* (In Chinese) [J]. Science & Technology Vision, 2012(4):65-67
- [4] Zhe Chen, Wenbing Chen and Fujian Yang: *The Research and Implementation of the Applications for Measuring the Parameters of Straight Spur Gears Based on VB* (In Chinese) [J]. Equipment Manufacturing, 2013(8):35-36
- [5] Chao Suo, Yuxiang Li and Shuzhong Lin: *Secondary Development of SolidWorks Parametric Design Based on VB Language* (In Chinese) [J]. Manufacturing Automation, 2013(8):137-139
- [6] Feng Guan, Chuanxi Zhou and Jiugang Yu: *Development of the Software for Six-bar Linkage of Shaper Based on Visual Basic* (In Chinese) [J]. Machine Tool & Hydraulics, 2013(10):23-25