Establishment of Chain Library Based on UG

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Abstract: Sprocket chain drive is a common transmission mode in mechanical engineering that is widely used. However, due to the complexity of sprocket chain manufacturing, the three-dimensional design and motion simulation and analysis using modern engineering software are time-consuming, and a great deal of calculations are needed. Therefore, it is of great significance to develop a sprocket chain reuse library based on the modern engineering software Unigraphics. Among them, the sprocket design library was designed many years ago and published relevant papers (establishment of sprocket parametric modeling and reuse library based on UG). Therefore, this time, the chain reuse library is mainly established for sleeve roller chains that meet the national standard (GB/t1243-2006), With the sprocket reuse library, 3D models can be established and assembled rapidly. The system was proven to be efficient and reliable through numerous engineering design verifications. This system makes engineering design, 3D assembly, and motion simulation easier and provides a reference for the development of other complex computing systems.

Keywords: Chain; UG; 3D design; Reuse library

1. Introduction

Modern mechanical products are usually designed using computer-aided design. Commonly used software programs include Unigraphics (UG), Solidworks, Catia, and other modern mechanical engineering software. These software programs offer high work efficiency, collaborative parallel design, and convenient product editing, with a parametric design function [1,2]. Besides, modern engineering software programs are capable of performing the whole life cycle management from product demand, planning, design, production, maintenance, and recycling. Therefore, nowadays, product design are primarily performed using modern engineering software.

Based on the AutoCAD development platform, Yang *et al.* [3] studied the three-dimensional (3D) parametric modeling of chain sprockets, developed a 3D modeling system of chain sprockets, and solved the problems of complex modeling and low design efficiency.

According to the national standard (GB/T 1243-2006) [4], sleeve roller chain design requires tedious calculations, which is time-consuming and inefficient. The 3D design of the sleeve roller chain requires referring to the mechanical design manual and carrying out complex calculations, and the chain assembly

is even more complicated [5]. There has been no mechanical engineering software dedicated to chain design. Therefore, it is necessary to develop a corresponding reuse library. This paper uses UG as the software development tool for the reuse library, introduces the process of establishing the chain reuse library in detail, and completes the basic assembly of the chain. Along with the sprocket reuse library completed in 2012 [6], it facilitates product design and 3D assembly.

2. Introduction of development software UG

UG is a modern engineering software that can complete 3D product modeling, 3D assembly, engineering drawing design, motion simulation, finite element analysis, product processing programming, mold design, and many other processes, making it an important tool for mechanical design and manufacturing. The software has the function of data association, and the 3D modeling data will be associated with the assembly data and engineering drawing. This allows convenient editing, high design efficiency, and low size errors. It is an excellent engineering software for the design and manufacture of modern mechanical products. It is widely used in the machinery industry, especially in the design and manufacture of automobiles, aerospace devices, and general engineering components [7].

UG provides a variety of specialized tools and modules, encompassing commonly used standard parts like bolts, bearings, and gaskets. It also includes solutions for more intricate designs such as gears and springs, along with specialized modules for specific purposes like automotive functional modules. However, due to the many types of mechanical products, with different shapes and complexity, it is impossible for a single engineering software to provide all the design modules needed. In order to solve this problem, UG allows users to develop their own product design modules using the function reuse library design. Through this function, users can design new modules for various products [8].

In this study, the design module of a chain sprocket was created using the UG reuse library function. In this design module, users only need to modify the basic parameters such as chain model, sprocket size, sprocket center distance, and chain row number, and the system can automatically complete the design calculations of each parameter and create a 3D design model. The completed 3D model can be used for motion simulation and other subsequent operations, which greatly simplifies the design process, facilitates 3D modeling, reduces complex design calculations, and improves the efficiency of mechanical design.

3. Establishment of modeling parameters

When designing with UG, the parameterization function provided by UG for design correlation can be utilized. For example, in order to determine the pitch dimensions of different types of chains, the data can be correlated through the chain model (code LH) in the form of the specific expression:

P=if (LH="04C") 6.35 else 9.525

In the expression above, LH indicates the chain number of the chain, and "04C" is one of the chain numbers of the chain, using the selection statement provided by UG:

if(condition) expression1 else expression2

Through this expression, the pitch of all chains can be listed, so that after the model is established, the model parameters of different types of chains can be obtained by modifying the parameter LH. This approach facilitates the adjustment of one parameter while automatically modifying others, which is the key to the establishment of a reuse library. In UG, there is a feature that allows the creation of expressions similar to those in the C language. This feature enables the utilization of common arithmetic operations (+, -, *, /, %), relational

operations (>, <, >=, <=, !=), and logical operations (&&, ||, !), thus enriching the way expressions are built [9,10]. Similarly, the expression building for the main dimensions of the chain can be accomplished, as shown in **Table 1**.

Table 1. Chain modeling parameters 1

No.	Parameter name	Parameter symbol	Expression
1	Pitch	p	if (LH="04C") 6.35 else if (LH="05B") 8 else if ((LH="06B")||(LH="06C")) 9.525 else if((LH="08A")||(LH="08B")||(LH="081")||(LH="083")||(LH="084")||(LH="085")) 12.7 else if((LH="10A")||(LH="10B")) 15.875 else if((LH="12A")||(LH="12B"))19.05 else if ((LH="16B")||(LH="16A")) 25.4 else if ((LH="20A")||(LH="20B")) 31.75 else if ((LH="24A")||(LH="24B")) 38.1 else if((LH="28A")||(LH="28B"))44.45 else if((LH="32A")||(LH="32B"))50.8 else if(LH="36A")57.15 else if((LH="40A")||(LH="40B"))63.5 ELSE 76.2
2	Roller diameter	d1	if (LH="04C") 3.3 else if (LH="06C") 5.08 else if (LH="05B") 5 else if (LH="06B") 6.35 else if (LH="08A") 7.92 else if (LH="08B") 8.51 else if ((LH="081")||(LH="083")||(LH="084")) 7.75 else if (LH="085") 7.77 else if ((LH="10A")||(LH="10B")) 10.16 else if (LH="12A") 11.91 else if (LH="12B") 12.07 else if ((LH="16A")||(LH="16B")) 15.88 else if ((LH="20A")||(LH="20B")) 19.05 else if (LH="24A") 22.23 else if ((LH="24B")||(LH="28A")) 25.4 else if (LH="28B") 27.94 else if (LH="32A") 28.58 else if (LH="32B") 29.21 else if (LH="36A") 35.71 else if (LH="40A") 39.68 else if (LH="40B") 39.37 else if (LH="48A") 47.63 else 48.26
3	Width between inner plates	b1	if (LH="04C") 3.1 else if (LH="06C") 4.68 else if (LH="05B") 3 else if (LH="06B") 5.72 else if (LH="08A") 7.85 else if (LH="08B") 7.75 else if (LH="081") 3.3 else if (LH="083") 4.88 else if (LH="084") 4.88 else if (LH="085") 6.25 else if (LH="10A") 9.4 else if (LH="10B") 9.65 else if (LH="12A") 12.57 else if (LH="12B") 11.68 else if (LH="16A") 15.75 else if (LH="16B") 17.02 else if (LH="20A") 18.9 else if (LH="20B") 19.56 else if (LH="24A") 25.22 else if (LH="24B") 25.4 else if (LH="28A") 25.22 else if (LH="28B") 30.99 else if (LH="32A") 31.55 else if (LH="32B") 30.99 else if (LH="36A") 35.48 else if (LH="40A") 37.85 else if (LH="40B") 38.1 else if (LH="48A") 47.35 else 45.72
4	Pin diameter	d2	if (LH="04C") 2.31 else if (LH="06C") 3.6 else if (LH="05B") 2.31 else if (LH="06B") 3.28 else if (LH="08A") 3.98 else if (LH="08B") 4.45 else if (LH="081") 3.66 else if ((LH="083")||(LH="084")) 4.09 else if (LH="085") 3.6 else if (LH="10A") 5.09 else if (LH="10B") 5.08 else if (LH="12A") 5.96 else if (LH="12B") 5.72 else if (LH="16A") 7.94 else if (LH="16B") 8.28 else if (LH="20A") 9.54 else if (LH="20B") 10.19 else if (LH="24A") 11.11 else if (LH="24B") 14.63 else if (LH="28A") 12.71 else if (LH="28B") 15.9 else if (LH="32A") 14.29 else if (LH="32B") 17.81 else if (LH="36A") 17.46 else if (LH="40A") 19.85 else if (LH="40B") 22.89 else if (LH="48A") 23.81 else 29.24
5	Sleeve diameter	d3	if (LH="04C") 2.34 else if (LH="06C") 3.62 else if (LH="05B") 2.36 else if (LH="06B") 3.33 else if (LH="08A") 4 else if (LH="08B") 4.5 else if (LH="081") 3.71 else if ((LH="083")||(LH="084")) 4.14 else if (LH="085") 3.62 else if (LH="10A") 5.12 else if (LH="10B") 5.13 else if (LH="12A") 5.98 else if (LH="12B") 5.77 else if (LH="16A") 7.96 else if (LH="16B") 8.33 else if (LH="20A") 9.56 else if (LH="20B") 10.24 else if (LH="24A") 11.14 else if (LH="24B") 14.68 else if (LH="28A") 12.74 else if (LH="28B") 15.95 else if (LH="32A") 14.31 else if (LH="32B") 17.86 else if (LH="36A") 17.49 else if (LH="40A") 19.87 else if (LH="40B") 22.94 else if (LH="48A") 23.84 else 29.29

The parameters in **Table 1** were entered into the UG expression. This process started with establishing a "chain" folder. In the newly created folder, the "expression" tool button on the UG tool panel was clicked. This action opened the "expression" dialog box, where the provided expression can be input. The resulting effect is depicted in **Figure 1**.
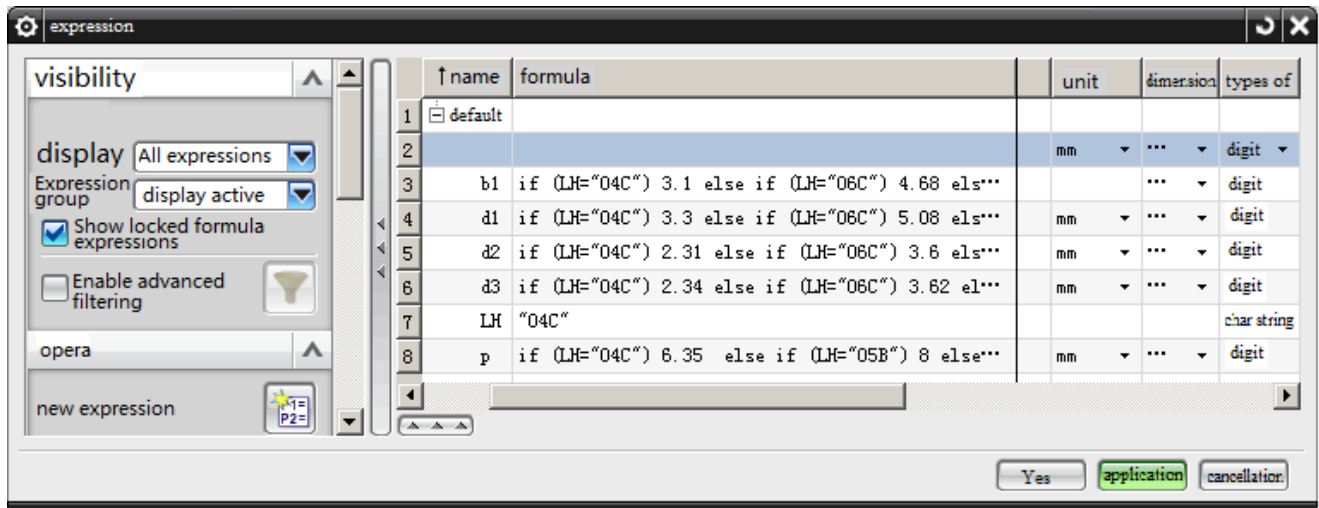
Figure 1. The effect of the main parameter input

Since UG expressions are dimensionally related, the input to the expression will be invalid if the dimension is wrong, Therefore, to facilitate the operation, other than some expressions of special significance, the expression of the outline can be set to a constant. In this expression, the dimension of LH was set to "string" and all other dimensions were set to constants.

Using the same method, other parameters related to the chain were edited to obtain the parameters in **Table 2**, which include the parameters of the single chain and the parameters of the multi-row chain. Among them, the parameters such as the height of chain channel h1, the height of the inner link (h2), the height of the outer or middle link (h3), the outer width of the inner link (b2), and the inner width of outer link (b3) are the basic parameters of the single-row chain. Meanwhile, the rest of the parameters are the parameters of the multiple-row chain for modeling the array. These two groups of parameters are crucial in establishing a three-dimensional model. Since no transition link was established in this development, an ordinary chain link was used to replace the transition link.

Table 2. Chain modeling parameters 2

6	Chain channel height	h1	if (LH="04C") 6.27 else if (LH="06C") 9.3 else if (LH="05B") 7.37 else if (LH="06B") 8.52 else if (LH="08A") 12.33 else if (LH="08B") 12.07 else if (LH="081") 10.17 else if (LH="083") 10.56 else if (LH="084") 11.41 else if (LH="085") 10.17 else if (LH="10A") 15.35 else if (LH="10B") 14.99 else if (LH="12A") 18.34 else if (LH="12B") 16.39 else if (LH="16A") 24.39 else if (LH="16B") 21.34 else if (LH="20A") 30.48 else if (LH="20B") 26.68 else if (LH="24A") 36.55 else if (LH="24B") 33.73 else if (LH="28A") 42.76 else if (LH="28B") 37.46 else if (LH="32A") 48.74 else if (LH="32B") 42.72 else if (LH="36A") 54.86 else if (LH="40A") 60.93 else if (LH="40B") 53.49 else if (LH="48A") 73.13 else 64.52
7	Inner chain plate height	h2	if (LH="04C") 6.02 else if (LH="06C") 9.05 else if (LH="05B") 7.11 else if (LH="06B") 8.26 else if (LH="08A") 12.07 else if (LH="08B") 11.81 else if (LH="081") 9.91 else if (LH="083") 10.3 else if (LH="084") 11.15 else if (LH="085") 9.91 else if (LH="10A") 15.09 else if (LH="10B") 14.73 else if (LH="12A") 18.1 else if (LH="12B") 16.13 else if (LH="16A") 24.13 else if (LH="16B") 21.08 else if (LH="20A") 30.17 else if (LH="20B") 26.42 else if (LH="24A") 36.2 else if (LH="24B") 33.4 else if (LH="28A") 42.23 else if (LH="28B") 37.08 else if (LH="32A") 48.26 else if (LH="32B") 42.29 else if (LH="36A") 54.3 else if (LH="40A") 60.33 else if (LH="40B") 52.96 else if (LH="48A") 72.39 else 63.88
8	Outer or middle chain plate height	h3	if (LH="04C") 5.21 else if (LH="06C") 7.81 else if (LH="05B") 7.11 else if (LH="06B") 8.26 else if (LH="08A") 10.42 else if (LH="08B") 10.92 else if (LH="081") 9.91 else if (LH="083") 10.3 else if (LH="084") 11.15 else if (LH="085") 8.51 else if (LH="10A") 13.02 else if (LH="10B") 13.72 else if (LH="12A") 15.62 else if (LH="12B") 16.13 else if (LH="16A") 20.83 else if (LH="16B") 21.08 else if (LH="20A") 26.04 else if (LH="20B") 26.42 else if (LH="24A") 31.24 else if (LH="24B") 33.4 else if (LH="28A") 36.45 else if (LH="28B") 37.08 else if (LH="32A") 41.68 else if (LH="32B") 42.29 else if (LH="36A") 46.86 else if (LH="40A") 52.07 else if (LH="40B") 52.96 else if (LH="48A") 62.49 else 63.88

Table 2 (Continue)

9	Row pitch	p1	if (LH="04C") 6.4 else if (LH="06C") 10.13 else if (LH="05B") 5.64 else if (LH="06B") 10.24 else if (LH="08A") 14.38 else if (LH="08B") 13.92 else if (LH="081") 0 else if (LH="083") 0 else if (LH="084") 0 else if (LH="085") 0 else if (LH="10A") 18.11 else if (LH="10B") 16.59 else if (LH="12A") 22.78 else if (LH="12B") 19.46 else if (LH="16A") 29.29 else if (LH="16B") 31.88 else if (LH="20A") 35.76 else if (LH="20B") 36.45 else if (LH="24A") 45.44 else if (LH="24B") 48.36 else if (LH="28A") 48.87 else if (LH="28B") 59.56 else if (LH="32A") 58.55 else if (LH="32B") 58.55 else if (LH="36A") 65.84 else if (LH="40A") 71.55 else if (LH="40B") 72.29 else if (LH="48A") 87.83 else 91.21
10	Inner section outer width	b2	if (LH="04C") 4.8 else if (LH="06C") 7.46 else if (LH="05B") 4.77 else if (LH="06B") 8.53 else if (LH="08A") 11.17 else if (LH="08B") 11.3 else if (LH="081") 5.8 else if (LH="083") 7.9 else if (LH="084") 8.8 else if (LH="085") 9.06 else if (LH="10A") 13.84 else if (LH="10B") 13.28 else if (LH="12A") 17.75 else if (LH="12B") 15.62 else if (LH="16A") 22.6 else if (LH="16B") 25.45 else if (LH="20A") 27.45 else if (LH="20B") 29.01 else if (LH="24A") 35.45 else if (LH="24B") 37.92 else if (LH="28A") 37.18 else if (LH="28B") 46.58 else if (LH="32A") 45.21 else if (LH="32B") 45.57 else if (LH="36A") 50.85 else if (LH="40A") 54.88 else if (LH="40B") 55.75 else if (LH="48A") 67.81 else 70.56
11	Outer section inner width	b3	if (LH="04C") 4.85 else if (LH="06C") 7.52 else if (LH="05B") 4.9 else if (LH="06B") 8.66 else if (LH="08A") 11.23 else if (LH="08B") 11.43 else if (LH="081") 5.93 else if (LH="083") 8.03 else if (LH="084") 8.93 else if (LH="085") 9.12 else if (LH="10A") 13.89 else if (LH="10B") 13.41 else if (LH="12A") 17.81 else if (LH="12B") 15.75 else if (LH="16A") 22.66 else if (LH="16B") 25.58 else if (LH="20A") 27.51 else if (LH="20B") 29.14 else if (LH="24A") 35.51 else if (LH="24B") 38.05 else if (LH="28A") 37.24 else if (LH="28B") 46.71 else if (LH="32A") 45.26 else if (LH="32B") 45.7 else if (LH="36A") 50.9 else if (LH="40A") 54.94 else if (LH="40B") 55.88 else if (LH="48A") 67.87 else 70.69
12	Pin length (single row)	b4	if (LH="04C") 9.1 else if (LH="06C") 13.2 else if (LH="05B") 8.6 else if (LH="06B") 13.5 else if (LH="08A") 17.8 else if (LH="08B") 17 else if (LH="081") 10.2 else if (LH="083") 12.9 else if (LH="084") 14.8 else if (LH="085") 14 else if (LH="10A") 21.8 else if (LH="10B") 19.6 else if (LH="12A") 26.9 else if (LH="12B") 22.7 else if (LH="16A") 33.5 else if (LH="16B") 36.1 else if (LH="20A") 41.1 else if (LH="20B") 43.2 else if (LH="24A") 50.8 else if (LH="24B") 53.4 else if (LH="28A") 54.9 else if (LH="28B") 65.1 else if (LH="32A") 65.5 else if (LH="32B") 67.4 else if (LH="36A") 73.9 else if (LH="40A") 80.3 else if (LH="40B") 82.6 else if (LH="48A") 95.5 else 99.1
13	Pin length (double row)	b5	if (LH="04C") 15.5 else if (LH="06C") 23.4 else if (LH="05B") 14.3 else if (LH="06B") 23.8 else if (LH="08A") 32.3 else if (LH="08B") 31 else if (LH="081") 0 else if (LH="083") 0 else if (LH="084") 0 else if (LH="085") 0 else if (LH="10A") 39.9 else if (LH="10B") 36.2 else if (LH="12A") 49.8 else if (LH="12B") 42.2 else if (LH="16A") 62.7 else if (LH="16B") 68 else if (LH="20A") 77 else if (LH="20B") 79.7 else if (LH="24A") 96.3 else if (LH="24B") 101.8 else if (LH="28A") 103.6 else if (LH="28B") 124.7 else if (LH="32A") 124.2 else if (LH="32B") 126 else if (LH="36A") 140 else if (LH="40A") 151.9 else if (LH="40B") 154.9 else if (LH="48A") 183.4 else 190.4
14	Pin length (three row)	b6	if (LH="04C") 21.8 else if (LH="06C") 33.5 else if (LH="05B") 19.9 else if (LH="06B") 34 else if (LH="08A") 46.7 else if (LH="08B") 44.9 else if (LH="081") 0 else if (LH="083") 0 else if (LH="084") 0 else if (LH="085") 0 else if (LH="10A") 57.9 else if (LH="10B") 52.8 else if (LH="12A") 72.6 else if (LH="12B") 61.7 else if (LH="16A") 91.9 else if (LH="16B") 99.9 else if (LH="20A") 113 else if (LH="20B") 116.1 else if (LH="24A") 141.7 else if (LH="24B") 150.2 else if (LH="28A") 152.4 else if (LH="28B") 184.3 else if (LH="32A") 182.9 else if (LH="32B") 184.5 else if (LH="36A") 206 else if (LH="40A") 223.5 else if (LH="40B") 227.2 else if (LH="48A") 271.3 else 281.6

The data in **Table 1** and **Table 2** were input into the "expression" tool provided by UG, and the process of building the 3D model was initiated. The inner and outer links of the chain were designed according to the UG design assembly mode [11,12]. This process started with establishing the "assembly" file, followed by the establishment of the inner chain and the outer chain. The outer chain consisted of two links: "outer chain plate" and "pin". The inner chain consisted of the "inner chain plate," "sleeve," and "roller." When building these parts, the parameters and dimensions provided in **Table 1** and **Table 2** were adopted. Through the 3D assembly of the established parts, the key model of the chain was obtained, as shown in **Figure 2**.
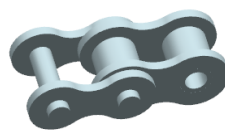

Figure 2. Assembly of inner and outer chain links of chain

The effect of the UG modeling assembly environment after establishing the 3D model is shown in **Figure 3**.

Figure 3. 3D assembly environment

The parts were assembled through constraints to complete the entire assembly of the inner and outer chain links. Finally, the inner and outer links were assembled, as shown in **Figure 2**.

4. Calculation of chain parameters

In actual engineering, the length of a chain is determined by the center distance, the number of teeth of the small sprocket and the large sprocket, the working conditions, such as the presence or absence of a drive belt tensioner, load characteristics, and other factors. To ensure the reuse library's usability after assembling, it is necessary to calculate the length of the chain and then display and assemble it according to the number of chain sections.

According to the different load characteristics, the initial center distance was divided into two cases of general load and pulsating load, and the specific calculation formulas are shown below.

$$a_{op} = \begin{cases} 40\,*p \text{ ……….……general condition} \\ 0.2*\,z_1*\,(i+1)i < 4, \text{ general condition} \\ 0.33*z_1*(i-1)*p……i > 4, \text{ general condition} \end{cases}$$

In the above formula, $i = \frac{z_2}{z_1}$, is the gear ratio. In order to convert the above formula into the calculation expression in UG environment, the load characteristic was set as Q; $Q = 0$ represents the general load, while $Q = 1$ represents the pulsating load, then it was converted into the expression in UG environment as follows:

$a_{op} = if\,(\,Q = 0\,)\,40*p\ else\ if\,(\,i < 4\,)\,0.2*\,z_1*\,(i+1)$
    $else\ 0.33*z_1*(i-1)*\,paop = if\,(\,Q = 0)\,40*p\ else\ if\,(i < 4)\,0.2*z_1*(i+1)$
        $else\ 0.33*z_1*(i-1)*\,p(1)$

After determining the initial center distance a_{op}, the number of chain links can be found, which is calculated using Equation (2):

$$L_p = \frac{z_1 + z_2}{2} + 2a_{op} + \frac{k}{a_{op}}\,(2)$$

Where L_p is the number of links under the given conditions. The prevent the use of transition links, L_p has to be an even number. Therefore, Equation (2) can be modified to the expression in the UG environment in order to make L_p an even number, and the results are as follows:

$$L_p = floor\,((z_1 + z_2)/2 + 2 * a_{op} + k/a_{op})/2)* 2$$

Equation (3) incorporates the "floor ()" function within the UG environment. This mathematical function serves to return the smallest integer resulting from the $(z_1 + z_2)/2 + 2 * a_{op} + k/a_{op})/2$ operation; the formula for the parameter k is as follows:

$$k = \left(\frac{z_2 - z_1}{2\pi}\right)^2 \quad ....(4)$$

Equation (4) was converted into an expression in the UG environment, and the result was as follows:

$$k = ((z_2 - z_1)/(2 * pi()))^2 \quad ....(5)$$

At this point, the number of chain links had been completed [13], and since the number of chain links had been made even through Equation (3), the number of inner and outer chain links was $\frac{L_p}{2}$ in the array assembly.

5. Inner and outer chain link assembly

To carry out array assembly, the operational approach involved creating a polygon with the coordinate origin as the center of the circle, the pitch p as the side length, and L_p as the side number. Following the relationship between the side length of the polygon and the coordinate origin, a straight line with the specified side length was generated. The starting coordinates of this straight line were then determined.

$$x_1 = -\frac{p}{2} \quad (6)$$

$$y_1 = \frac{\frac{p}{2}}{\tan\left(\frac{180}{L_p}\right)} \quad (7)$$

The end coordinates of the corresponding line are:

$$x_2 = \frac{p}{2} \quad (8)$$

$$y_2 = \frac{\frac{p}{2}}{\tan\left(\frac{180}{L_p}\right)} \quad (9)$$

After completing the production of the line, use the "array Geometry feature" command to set the array vector to the Z axis direction, the center point of the array to the coordinate origin, the number of arrays to , and the pitch Angle of the array to $\frac{360}{L_p}$, and array the completed line to obtain a polygon with side length p and side number L_p.

After creating the polygon, we proceeded to assemble an inner link and an outer link separately. Subsequently, we employed the "array components" command for array assembly. During the assembly process, the roller centers at both ends of the chain section were aligned and overlapped with the length of the polygon side. The array vector was set in the Z-axis direction, the center point of the array was designated as the coordinate origin, the number of arrays was set to $\frac{L_p}{2}$, and the pitch angle of the array was configured as $\frac{720}{L_p}$ to complete the array. The assembly effect when and is shown in in **Figure 4**.
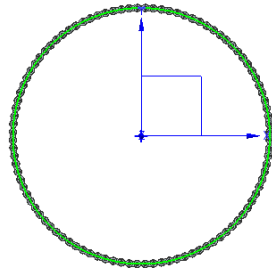
Figure 4. Effect after assembly

6. Establishment of standard parts library

A new "Chain Components" folder was created, all the files made earlier was copied to this folder, and the following three files was created under it.

(1) The "chain GBT1243-2006.bmp" image file was established, which consisted of the assembled parts, as shown in **Figure 5**.
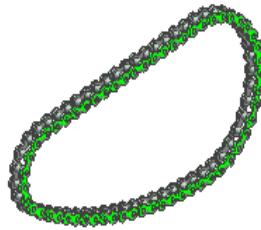

Figure 5. Image file

(2) A file "Chain GBT1243-2006.xls" was created to list the chain parameters of all models, as shown in **Figure 6**.

DB_PART_NO	OS_PART_NAME	LH	z1	z2	q
1	GBT1243-2006-04C	"04C"	18	25	0
2	GBT1243-2006-06C	"06C"	18	25	0
3	GBT1243-2006-05B	"05B"	18	25	0
4	GBT1243-2007-06B	"06B"	18	25	0
5	GBT1243-2008-08A	"08A"	18	25	0
6	GBT1243-2009-08B	"08B"	18	25	0
7	GBT1243-2010-081	"081	18	25	0
8	GBT1243-2011-083	"083"	18	25	0
9	GBT1243-2011-084	"084"	18	25	0
10	GBT1243-2011-085	"085"	18	25	0
11	GBT1243-2014-10A	"10A"	18	25	0
12	GBT1243-2015-10B	"10B"	18	25	0
13	GBT1243-2016-12A	"12A"	18	25	0
14	GBT1243-2017-12B	"12B"	18	25	0
15	GBT1243-2018-16A	"16A"	18	25	0
16	GBT1243-2019-16B	"16B"	18	25	0
17	GBT1243-2020-20A	"20A"	18	25	0
18	GBT1243-2021-20B	"20B"	18	25	0
19	GBT1243-2022-24A	"24A"	18	25	0
20	GBT1243-2023-24B	"24B"	18	25	0
21	GBT1243-2024-28A	"28A"	18	25	0
22	GBT1243-2025-28B	"28B"	18	25	0
23	GBT1243-2026-32A	"32A"	18	25	0
24	GBT1243-2027-32B	"32B"	18	25	0
25	GBT1243-2028-36A	"36A"	18	25	0
26	GBT1243-2029-40A	"40A"	18	25	0
27	GBT1243-2030-40B	"40B"	18	25	0
28	GBT1243-2031-48A	"48A"	18	25	0
29	GBT1243-2032-48B	"48B"	18	25	0
30	GBT1243-2033-56B	"56B"	18	25	0
31	GBT1243-2034-64B	"64B"	18	25	0
32	GBT1243-2035-72B	"72B"	18	25	0

Figure 6. xls worksheet content

(3) The "Chain GBT1243-2006.krx" file was established [14-16], which is as follows:

```
<?xml version="1.0" encoding="UTF-8"?>
<KnowledgeReuse>
<ItemData>
<Part Location="final assembly.prt"/>
<KeyParameter DescriptiveName="LH">LH</KeyParameter>
    <DataFile Location="../../../../LOCALIZATION/prc/GB Standard Parts/chain/chainGBT1243-2006.xls"/>
    <DetailImage Location="../../../../LOCALIZATION/prc/GB Standard Parts/chain/chainGBT1243-2006.bmp"/>
</ItemData>
<MatchData GeomType="" ParaName="OS_PART_NAME" ValueMatch="GE"/>
<FamilyMemberSaveDir>C:\Program Files\Siemens\NX 12.0\LOCALIZATION\prc\GB Standard Parts\chain\</FamilyMemberSaveDir>
</KnowledgeReuse>
```

After the above three files were created, we copied the "Chain Components" folder to the UG installation directory Siemens\NX 12.0\prc\GB Standard Parts\, UG was initiated, and the "GB Standard Parts" icon in the reuse library in the navigation bar was clicked, where the "Chain Components" folder could be seen. Subsequently, by dragging the "Assembly" icon into the UG assembly environment, the "Add Requisition Library Component" dialog box, as depicted in **Figure 7**, appeared. To modify the data of the "chain number" LH, adjustments to the model could be made to obtain the desired chain component. By double-clicking to modify z_1, and z_2, the number of teeth of the size sprocket could be altered. Similarly, by double-clicking on q, adjustments could be made to specify whether the chain load is a pulsating load. A default value of 0 indicated a general load, while 1 indicated a pulsating load. Thwn, by clicking "OK" the chain component was established.
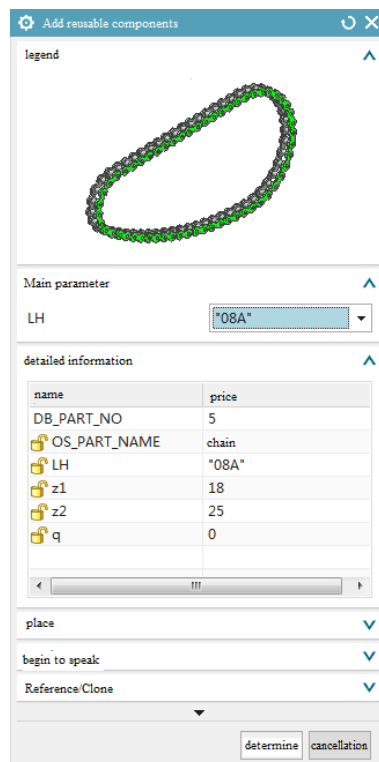

Figure 6. Dialog box of adding requisition library component

7. Conclusion

The challenge of intricately assembling numerous small parts in the realm of 3D modeling was effectively addressed through the creation of an assembly component library using parametric modeling techniques. Simultaneously, the system's calculation function is leveraged to automatically compute the number of chain links and the center distance in chain drives, significantly reducing the burden of design calculations. This not only enhances the speed and quality of product design but also simplifies the once-complex process of three-dimensional modeling, thereby boosting overall work efficiency. This approach allows designers to focus more on intricate design tasks rather than spending extensive time on three-dimensional modeling and assembly. This shift in focus contributes to heightened work efficiency and ensures the accuracy and precision of design calculations. Through extensive engineering practice, the effectiveness of the reuse library has been validated, aligning well with the practical demands of chain drive applications, and garnering high user satisfaction. The developed design system not only offers a practical solution for the development and research of other complex computing systems in engineering design but also serves as a valuable reference for the design of intricate common systems.

Disclosure statement

The authors declare no conflict of interest.

References

[1] Li J, Zhong Q, Cheng Y, 2012, Parametric Modeling of Sprocket and Establishment of Reuse Library Based on UG. Mechanical Drive, 2012(9): 57–62.

[2] Zhang Z, Liu H, Tie X, et al., 2018, Influence of Load Ratio of Tapered Roller Bearings on Life. Bearing, 2018(6): 28–32 + 39.

[3] Li R, Duan B, Yang M, et al., 2018, Load Distribution and Life Calculation of Double Row Tapered Roller Bearings for Wind Turbines. Bearing, 2018(5): 1–6.

[4] Liu G, Yang J, Yang X, et al., 2018, Life Modified of Cross Universal Joint Bearing with Considering Clearance and Deflection. Journal of Mechanical Transmission, 42(9): 36–41.

[5] Lu L, Yu Y, Zeng G, 2017, Fatigue Life Comparative Analysis of Rolling-sliding Bearing based on nCode DesignLife. Journal of Mechanical Transmission, 41(3): 114–119.

[6] Yu S, Wu T, Luo J, 2016, Introduction to MATLAB GUI Design and Practical, Tsinghua University Press, Beijing.

[7] Wang G, Xing L, 2018, MATLAB GUI Design, Tsinghua University Press, Beijing.

[8] Qin D, Xie L, 2011, Modern Mechanical Design Manual, Chemical Industry Press, Beijing.

[9] Mechanical Engineering Material Performance Data Book Editorial Board, (eds)1995, Mechanical Engineering Material Properties Data Manual China Machine Press, Beijing.

[10] Chen J, 2004, Digital Design of Bearings and its Application of High-Speed Ceramic Ball Bearing in the Structural Parameter Design, dissertation, Tianjin University, Tianjin.

[11] Liu Z, 2014, Application Manual of Rolling Bearing, China Machine Press, Beijing.

[12] Okamoto J, 2003, Design Calculation of Ball Bearing, [Huang Z Trans], China Machine Press, Beijing.

[13] Pu L, Chen G, Wu L, et al., 2019, Mechanical Design, Higher Education Press, Beijing, 330–332.

[14] Yang X, 1995, Effect of Groove Radius Coefficient on Load Capacity of Deep Groove Ball Bearing. Bearing, 1995(6): 5–7.

[15] Ye Z, Zhu Z, Zhang Q, et al., 2016, Fatigue Life Calculation Method of Angular Contact Ball Bearing Based on Equivalent Contact Load. Mechanical and Electrical Technology, 2016(4): 17–19.

[16] Ji B, Jing M, Liu H, et al., 2016, Fatigue Life Analysis and Research on Double Row Angular Contact Ball Bearing. Mechanical Design & Manufacturing, 2014(10): 26–28 + 31.