International Journal of Database Theory and Application
Vol.9, No.3 (2016), pp.19-24
http://dx.doi.org/10.14257/ijdta.2016.9.3.03

# Simulation Research and Parameter Optimization for Hypoid Gear NC Machining

Hu Hong[1, a] and Zhu xiurong[1,b]

*1. JiLin Engineering Normal University, Changchun 130052, China*
*[a]799517839@qq.com, [b]zxr67811@163.com*

***Abstract***

*The paper studied hypoid gear CNC machining theory and simulation processing. Through construct a simulation case of hypoid gear machining system, optimization processing parameters for the main aspects, verify the effectiveness of pre-correction system.*

***Keywords***: *Hypoid gear; NC machining; Parameter optimization; Simulation Processing*

## 1. Introduction

Production hypoid gear now plays an important in modern machinery manufacturing industry, in particular account for a large proportion of automobiles, machinery and industrial production [1-3].

With the continuous development of China's industry, the production output hypoid gear is rapidly growing with. In gear, especially at the intersection of the axis of the mechanical transmission, straight bevel gears are widely used. Because straight bevel gear ratio hypoid gears are easy to design and processing, the tooth mechanical transmission line does not produce an axial force. However, the mechanical transmission process in motion stabilization and carrying capacity. Straight bevel gear but not as good as hypoid gears [4-6].

High hypoid strength to work more smoothly, suitable for relatively large reduction gear, tooth wear uniform, improve the contact area, the tooth surface finish can be improved while reducing noise. So widely used in the car almost hypoid gears. To this end, we propose a theoretical parameter processing hypoid gears and simulation research is necessary.

## 2. Hypoid Gear Pairs of Basic Geometric Design

Hypoid gear blank design shown in Figure 1.

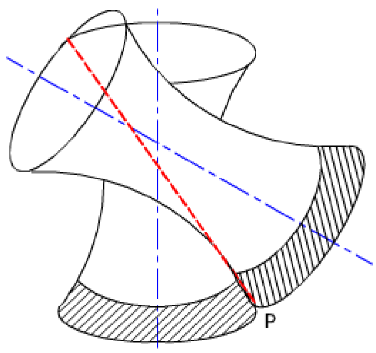


**Figure 1. Hypoid Gear Blanks Design**

ISSN: 2005-4270 IJDTA
Copyright ⓒ 2016 SERSC

Shaft drive space staggered relative motion spiral movement, which spiral around the axis of rotation of each gear axis to form a double curved surface [7-8].

The geometry of hypoid gear pair is shown in Figure 2.

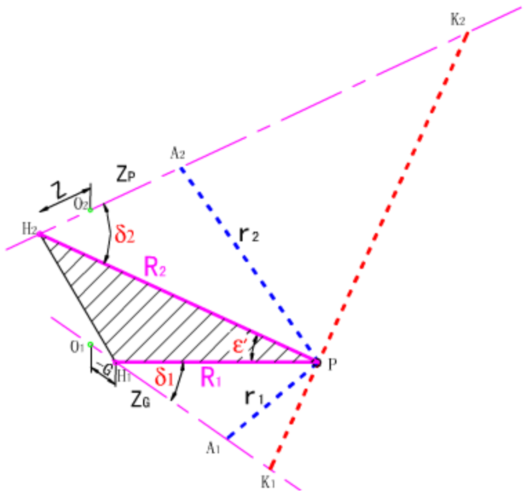


**Figure 2. The Geometry of Hypoid Gear**

K1K2 ——vertical section
H1PH2—— nodal plane
H1, H2 ——cone top
H1P——Ferry cone distance R1
H2P ——big wheel cone distance R2
δ1——Ferry pitch angle
δ2—— big wheel pitch angle
ε—— offset angle

Small round pitch radius r1, r2 great circle pitch radius. Section plane into two sections cone co section, section cone is approximately double the surface. Hypoid gear section vertebral constructed as shown in Figure 3.

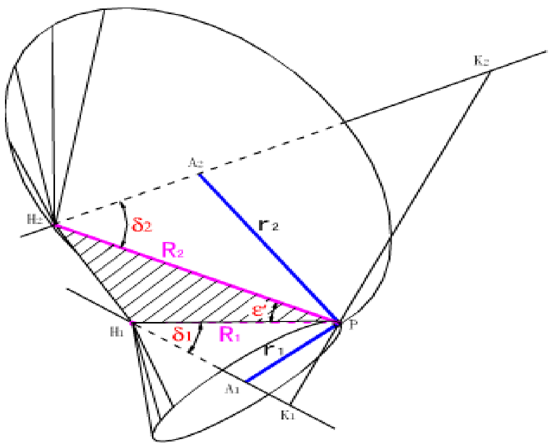


**Figure 3. Hypoid Bevel Gear Section**

## 3. Hypoid Gear Design Parameter Calculation Method

Modern spreadsheet software such as EXCEL can be used for custom table, statistical general data calculations. However, it also has many additional features, such as having


Copyright ⓒ 2016 SERSC

more commonly used libraries [9-10] (mathematical, trigonometric, financial calculation functions, statistical functions, *etc.*),

You can easily input data and various calculations. There are general data graphing, lifting sorting, filtering, and other functions specific items can be used for data analysis, Drawings, preferred work. Use these existing capabilities needed to carry out the design parameters of spiral bevel gear in the spreadsheet calculations, it is possible to make our workload and error rate, at the same time is reduced significantly in ensuring the accuracy. Instead, it is a substantial increase in computing speed, and can be more attention to points on the gear and machine parameters Research and analysis on the relationship between the adjustment parameters bed [11-13].

**Table 1. Initial Calculation Parameters**

| No. | Name | Calculation Parameters |
|---|---|---|
| 1 | Gear | 38 |
| 2 | Pitch circle diameter | 286.2499 |
| 3 | Spiral direction | Right-handed |
| 4 | End face modulus | 8.4388 |
| 5 | Pressure Angle | 20 |
| 6 | Normal pressure angle | 20.5 |
| 7 | Pitch angle | 78.85 |
| 8 | Surface taper angle | 79.35 |
| 9 | Root angle | 74.7667 |
| 10 | Facewidth midpoint helix angle | 36.9828 |
| 11 | Tooth width midpoint cone distance | 168.619 |
| 12 | Tooth width midpoint addendum | 1.132 |
| 13 | Tooth width midpoint dedendum | 12.607 |
| 14 | Radial pockets | 99.6012 |
| 15 | Basic Knife corner | 324.5255 |
| 16 | Vertical wheel position | 24.4895 |
| 17 | Roll ratio | 4.31167 |

The parameters of hypoid gear in the corresponding position on the CNC machine is shown in Figure 4.

**Figure 4. Corresponding Position on the Machine**

## 4. Hypoid Gear Machining Simulation

Virtual machining system can be constructed by means of an auxiliary computing gear design and manufacturing parameters and their simulation results. Through the virtual gear accomplished visualization analysis, and the use of the auxiliary parameter calculation module to determine project value adjustment calculation can be used to optimize the design and processing parameters gear for parameter error correction [14-16].

### 4.1 Shaping Method of Processing the Large Gears

In the CATIA software, parameter adjustment based on the establishment of the machine coordinate system, the large gear coordinate system, cutter coordinate system. Adjust parameters to complete the modeling. Form method using the processing of large gears [17].

### 4.2 Knife Decantation Process Pinion

Between the pinion and the presence of cradle roll than in three-dimensional AutoCAD software, depending on the machine to adjust the parameters, set up the machine coordinate system, the pinion coordinate system, cutter coordinate system, then, according to roll over, to establish a series of round billet envelope line, fitted envelope surface, generated by cutting the body surface, use arrays and Boolean operations, complete modeling. Pour method using a knife machining pinion. At this point, we can make the NC machining simulation. Surface optimization process to determine a reasonable argument [18-20].

Repeatedly set the parameters, the simulation process, select the best parameters to determine the optimal solution. Hypoid gear simulation process shown in Figure 5. The diagram of hypoid large and small wheel assembly is shown in Figure 6.


Copyright ⓒ 2016 SERSC

**Figure 5. Hypoid Gear Machining Simulation**

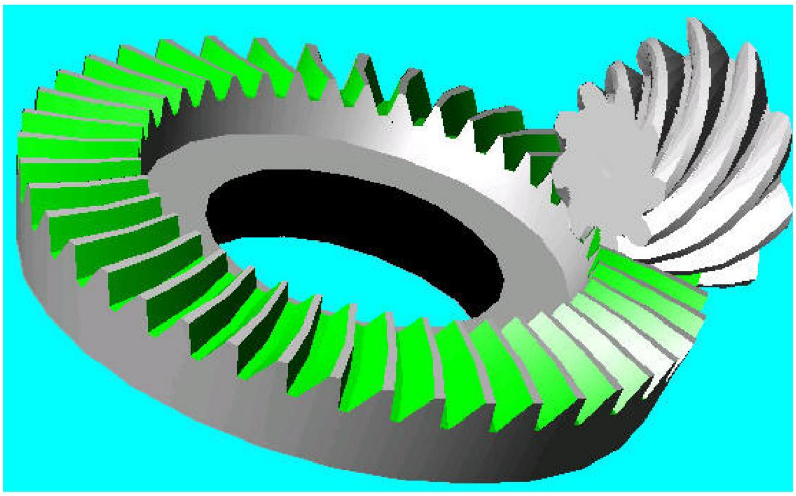

**Figure 6. Hypoid Large and Small Wheel Assembly Drawing**

## 5. Conclusion

In this paper, processing methods of the hypoid gears, and other major aspects of modeling and simulation conducted some research on the formation of some theoretical results hypoid gear manufacturing system to build a hypoid gear machining simulation system. Of course, hypoid field there are many problems need to be continued in-depth study.

## References

[1] F. L. Litvin, "Development of Gear Technology and Theory of Gearing", NASA RP-1406, **(2002)**.
[2] S. Z. Jian, W. Xutang and M. Shi, "Hypoid gear design Tooth Surface representation of Xi'an Jiaotong University", vol. 39, no. 1, **(2005)**, pp. 17-20.
[3] L. Xiaoyong, "Spiral bevel gear CNC machining theory study", [MS Thesis], Zhengzhou University, **(2002)**.

[4] Z. Wei, W. T. Yong, H. Huilong and D. Hui, "Network, a numerical simulation system to improve the program, and a hydraulic machine", vol. 199, no. 10, **(2006)**, pp. 165-166.
[5] X. Yuedong, W. T. Yong and Z. Wei, "Spiral bevel gear CNC milling machining process simulation study geometry", Machine Tools and Hydraulic, no. 6, **(2005)**, pp. 1-4.
[6] Z. Wei, W. T. Yong, X. Yuedong and Z. Huijiang, "Machine simulation system to achieve more hybrid programming environment", Manufacturing Automation, vol. 28, no. 6, **(2006)**, pp. 25-27.
[7] F. L. Litvin and A. Fuentes, "Gear geometry and applied theory", Cambridge University Press, Cambridge, **(2004)**.
[8] Z. Wei and W. Taiyong, "A virtual system solution of CNC machine for spiral bevel and hypoid gears", Transaction of Tianjin University, vol. 12, no. 5, **(2006)**, pp. 373-377.
[9] Z. Wei, "Hypoid gear CNC machining theory and simulation studies [PhD thesis]", Tianjin University, **(2007)**.
[10] C. Yaonan, H. Yu, L. Zhenzhen, L. Li and L, Yizhi, "The Optimization Design and Analysis of Efficient Layer Cutting Milling Cutter for Water Chamber Head Machining", Journal of Harbin University of Science and Technology, vol. 20, no. 3, **(2015)**, pp. 1-7.
[11] G. H. He, X. L. Liu and F. G. Yan, "Research on the Application and Design of Special Tools of the Hydrogenated Cylindrical Shell", Advanced Materials Research, vol. 188, **(2011)**, pp. 450-453.
[12] R. D. Fu, T. S. Wang and W. H. Zhou, "Characterization of Precipitates in a 2. 25Cr- 1Mo- 0. 25V Steel for Large Seale Cast Forgedb Produets", Materials Characterization, vol. 58, no. 10, **(2007)**, pp. 968-973.
[13] Z. Anshan, L. Xianli, L. Maoyue, W. Guangyue and T. Xin, "An Approach to Non- Ball- End Milling of Automobile Covering Mold with Large Machining Strip Width", Journal of Harbin University of Science and Technology, vol. 19, no. 1, **(2014)**, pp. 5-11.
[14] M. Engeli and J. Waldvogel, "Method for Processing Work Pieces by Removing Material: United States", US 6485236 B1, **(2002)**, pp. 11-26.
[15] C. J. Chiou and Y. S. Lee, "A Machining Potential Field Approach to Tool Path Generation for Multi-axis Sculptured Surface Machining", Computer Aided Design, vol. 34, no. 5, **(2002)**, pp. 357-371.
[16] J. H. Yoon, H. Pottmann and Y. S. Lee, "Locally Optimal Cutting Positions for 5- axis Sculptured Surface Machining", Computer Aided Design, vol. 35, no. 1, **(2003)**, pp. 69-81.
[17] G. Catania, "A Computer- aided Prototype System for NC Rough Milling of Flee- form Shaped Mechanical Part- pieces", Computers in Industry, vol. 20, no. 2, **(1992)**, pp. 275 -293.
[18] C. Zhu, "Tool-path Generation in Manufacturing Sculptured Surfaces with a Cylindrical End- milling Cutter", Computers in Industry, vol. 17, **(1991)**, pp. 385-89.
[19] S. H. Masood, V. K. Bagam and P. Chantanabubpha, "A Computerized Minimum Distance Algorithm for Machining of Sculptured Surfaces", Computer Aided Design, vol. 42, **(2002)**, pp. 291-297.
[20] Y. Huang and J. H. Oliver, "Non- constant Parameter NC Tool Path Generation on Sculptured Surfaces", The International Journal of Advanced Manufacturing Technology, vol. 9, **(1994)**, pp. 281-290.

 Copyright ⓒ 2016 SERSC