Research on Measuring key Errors of Plane-generated Enveloping Hourglass Worm

Hong Lu\textsuperscript{1,a}, Zhi Liu\textsuperscript{2*,b}

\textsuperscript{1,2}School of Mechanical and Electronic Engineering, Wuhan University of Technology, Wuhan, China

\textsuperscript{a}landzh@whut.edu.cn, \textsuperscript{b}lz3839@126.com

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Abstract: Plane-generated double enveloping hourglass worm pair has unique characteristics of double contact line; it has the advantages of wide tooth working area, large bearing capacity, and long service life, etc. However, its development has been restricted by such factors as difficulty in measuring, worse processing precision, etc. In this article, a modeling approach is presented in order to obtain the meshing point’s coordinates of the plane–generated enveloping hourglass worm based on theoretic analysis and computer-aided design principle. And a measuring equipment system is designed to measure the meshing point’s coordinates. Key errors of this worm have been discussed and obtained by comparing the theoretic coordinates and the measuring coordinates. Finally, an experimental study has been carried out to validate the modeling method and measuring equipment system.

INTRODUCTION

The Plane–generated double enveloping hourglass worm pair has been widely applied in heavy load driving transmission field due to its excellent meshing characteristics. CAD/CAM technologies are used for modeling and theoretic analysis of this worm pair. And the meshing points can be measured by three coordinates measuring instrument [1-2]. The modeling method of helical surfaces which enveloped by cylindrical part was discussed, and an algorithm was developed aims at detect the precision of the helical surfaces[3].Contact condition was analyzed by geometrical simulation of worm gear tooth using intersection profiles of different axial sections of worm representing the hob tooth profile with transverse plane of worm gear[4].Because of the complexity of its tooth surface, it is difficult to measure the worm pair precisely. In order to develop the manufacturing accuracy of the worm, research about the worm’s theoretical modeling and new equipment for error measuring is introduced, which uses grating to do a contact measuring for the worm dynamically. Finally, a measuring experiment is conducted using this equipment system.

MEASURING PRINCIPLE

2.1 Theoretic analysis
As shown in Fig.1, firstly, using mother plane $\Sigma 0$ envelope out worm surface $\Sigma 1$, and then, use the surface $\Sigma 1$ envelope out worm wheel surface $\Sigma 2$.

(1) Notation

- $a$: Center distance;
- $\beta_0$: The mother plane obliquity; $o_1(x_1,y_1,z_1)$
- $o_1(x_1,y_1,z_1)$: The fixed coordinate system on worm;
- $o_1(x_1,y_1,z_1)$: The reference coordinate system of worm;
- $o_2(x_2,y_2,z_2)$: The fixed coordinate system on wheel worm;
- $o_2(x_2,y_2,z_2)$: The reference coordinate system of worm wheel;
- $o_3(u,v,w)$: The mother plane coordinate system;
- $\phi_1$: Worm rotation parameter;
- $\phi_2$: Worm wheel rotation parameter;