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# THREE-DIMENSIONAL ENTITY MODEL AND MOVEMENT EMULATION OF REDUCER BASED ON UG PLANE

**Abstract**: This article introduces to modeling for reducer with three-dimensional entity by MOSWLING module in the latest edition UG NX of UG software, which mainly concern with model of the main components such as shaft, gear, gear shaft, mount and cover and complete corresponding assembly. Then, carry out movement emulation for all the assembly with MOTION module.

**Keywords**: UG; three-dimensional entity model; reducer; emulation

UG is three-dimensional entity model plane which integrates CAD/CAM/CAE, and is computer aided design, analysis and manufacture software which is used widely in the world. There are several problems should be paid attention to in this article: involutes tooth profile model of gear teeth, hollowing operation of cover when modeling, location between gear shaft and gear when assembling.

## 1 Plotting involutes tooth profile of gear teeth

Involutes tooth profile of gear teeth can be plotted with "expression" in UG [3]. On the other hand, this article program for involutes tooth profile of gear teeth with VC++ 6.0 and save coordinate value of tooth profile surface in corresponding data file, and plot involutes tooth profile of gear teeth using "read point from file" in spline with the defined point.

Polar coordinates parameter equation of involutes is [4]

$$\begin{cases} r_k = \dfrac{r_b}{\cos\alpha_k} \\ \theta_k = inv\alpha_k = \mathrm{tg}\alpha_k - \alpha_k \end{cases}$$

make $r_k$ and $\theta_k$ go to $\begin{cases} x_k = r_k \cdot \cos\theta_k \\ y_k = r_k \cdot \sin\theta_k \end{cases}$ and spread with trigonometric expressions, can get:

$$\begin{cases} x_k = r_b \cdot [\cos(\theta_k + \alpha_k) + (\theta_k + \alpha_k) \cdot \sin(\theta_k + \alpha_k)] \\ y_k = r_b \cdot [\sin(\theta_k + \alpha_k) - (\theta_k + \alpha_k) \cdot \cos(\theta_k + \alpha_k)] \end{cases}$$

Here $r_k$ is radius of involutes tooth profile at $K$ point, $\theta_k$ is angle of involutes at AK segment, $r_b$ is base radius and $\alpha_k$ is pressure angle at K point.

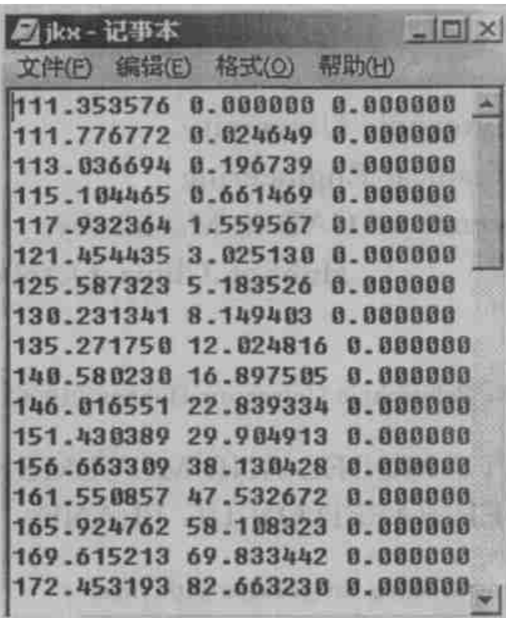


Fig. 1

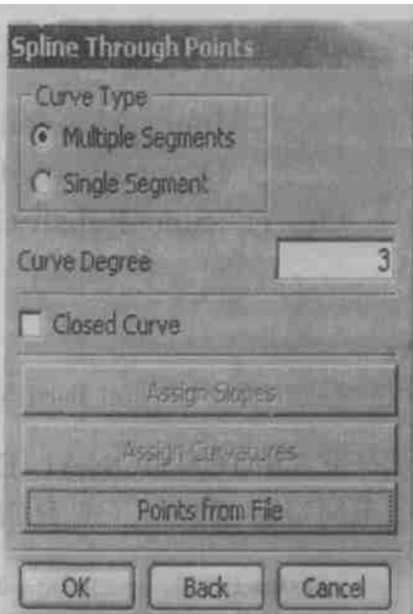


Fig. 2

Program with VC++ 6.0 and change ($\theta_k + \alpha_k$) from 0 to 180, can get corresponding $x_k$ and $y_k$, and save them in corresponding data file jkx.dat. The results like Fig. 1.

Insert→Curve→Spline in UG main menu , click "Through Points" button after showing dialogue, then the system show dialogue Spline Through Points like Fig. 2. Click "Points From File" button and select before-mentioned data file jkx.dat, can get corresponding involutes like Fig. 3.

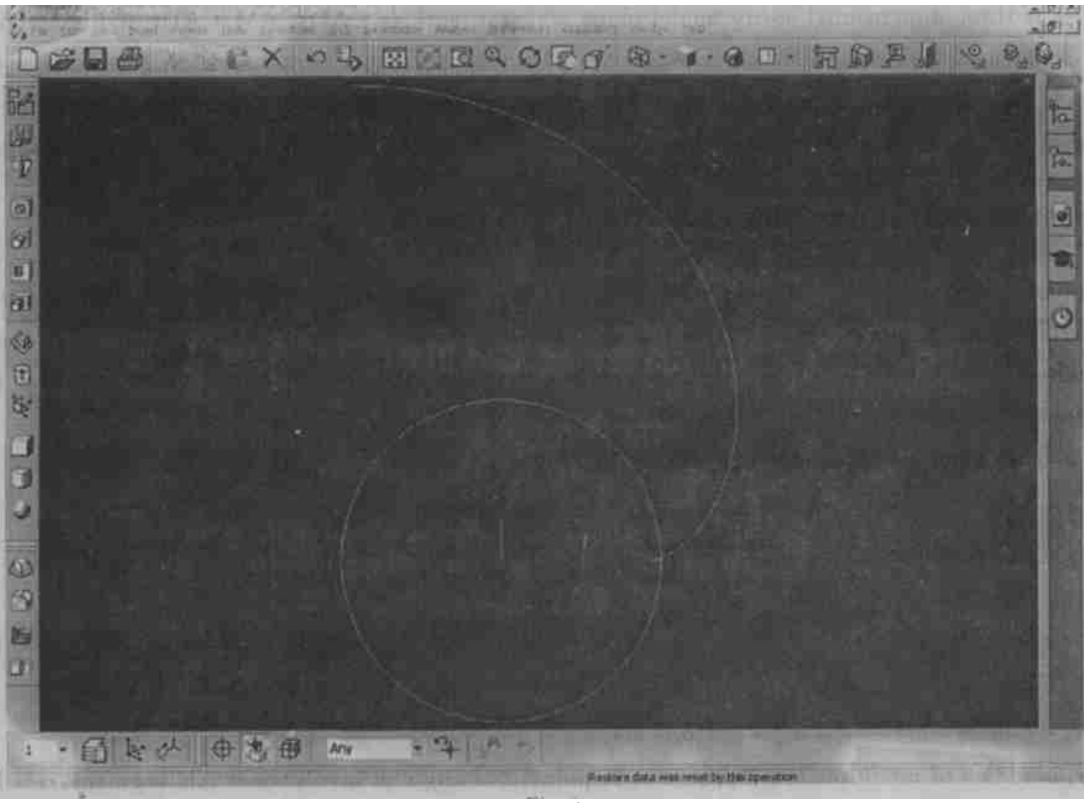

Fig. 3

Because tooth thickness and tooth spacewidth of reference circle is equality, the opposite center angle of gear teeth and tooth space is equality, then the opposite center angle of half tooth thickness is $\frac{1}{2}\cdot\frac{\frac{360^\circ}{2}}{z}$, viz $\frac{90^\circ}{z}$, here $z$ is number of teeth. XC axis should be rotated $\theta_k+\frac{90^\circ}{z}$ and make the above $\theta_k$ expression go to, corner is $\mathrm{tg}\alpha_k-\alpha_k+\frac{90^\circ}{z}$. Because of the pressure angle of reference circle of standard gear is 20°, so XC axis should be rotated $(\mathrm{tg}20^\circ-20\times3.1415926/180)/3.1415926\times180^\circ+\frac{90^\circ}{z}$. Plot a line at XC axis, and select the line as center of mirror and mirror involutes with "Existing Line" in "Mirror Through a Line". The radius of the angle between tooth profile surface and roof is $\beta=\frac{c^*\cdot m}{1-\sin\alpha_i}$, here $m$ is module, $\alpha_i$ is nominal pressure angle, $c^*$ is bottom clearance coefficient[2]. At last, can get three-dimensional entity model of gear with tripping, cornering and stretching. like Fig. 4.

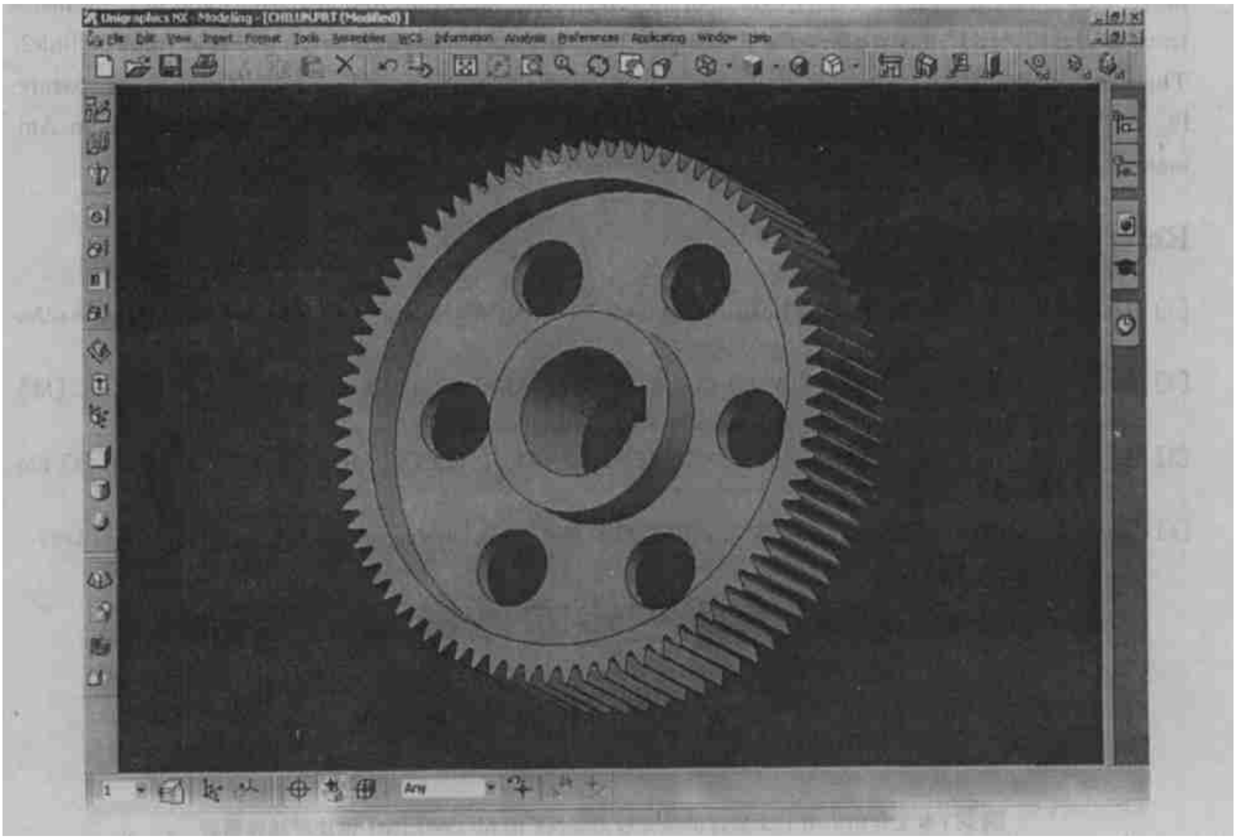

Fig. 4

At the same method, can get gear teeth involutes tooth profile of gear shaft.

## 2　Some problems should be paid attention to when modeling cover

Hollow cover after completing the whole model of cover, can get partial entity and can't get the perfect full entity. Here, we use "Region" in "Hollow" and change cover into two parts: bearing seat, protuberant level and boarding body which is connect with mount is one part, the other is another part, and hollow separately. The key point is the two parts cannot Unite before hollowing and must be United after hollowing. We think the complicated body should be disintegrated into simple bodies and be hollowed separately, then Unite.

## 3 Location of gear shaft and gear when assembling

Axial location between gear and gear shaft is not confirmed when they are assembled on mount, so intervening can happen among gear teeth. There are eight types restriction in UG [], such as Mate, Align, Angle, Parallel, Perpendicular, Center, Distance and Tangent, but they all cannot set up mating relation of two gears. Therefore, it is necessary to plot corresponding location surface during the course of entity model of gear shaft and gears. Here we plot centerline of tooth space of gear shaft and centerline of gear teeth and the two lines should be kept parallel each other during the course of assembly, so the intervening among teeth can be avoided. We keep the above two lines separately parallel with fringe lines of mount with Parallel restriction relation, so the two lines may be parallel more. Thereby, gear teeth cannot intervene during the course of engagement.

We complete three-dimensional entity model of the main components of reducer. Then, we make movement emulation for it. First, establish movement analysis case, and gear shaft and bearing inside track is link 1, and shaft, gear, fixed-distance loop and corresponding bearing inside track is link2. Then, set up Joint for movement unit, namely set up Revolute between gear shaft and gear separately. At last, set up Compound -Gear of revolute1 and 2. Select Kinematic/Dynamic Analysis in Animation, and input Time and Step, we can make movement emulation for reducer.

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# 基于 UG 的减速器三维实体模型和运动仿真


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摘要: 本文介绍了用 UG 软件的最终版 UG NX 的 MOSWLING 模块对减速器进行了三维实体造型, 主要零件包括轴、齿轮、齿轮轴、下箱体、上箱体及相应的装配. 最后在 UG 的 MOTION 模块中对装配模型进行了运动仿真.



关键词: UG; 三维实体模型; 减速器; 仿真

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