The Journal of Polish Society for Geometry and Engineering Graphics
Volume 15 (2005), 63 – 66

CAMS PROFILE GUIDE LINE DESIGN WITH MECHANICAL DESKTOP SYSTEM

Vidmantas NENORTA, Robertas KERSYS, Nomeda PUODZIUNIENE

Department of Engineering Graphics
Kaunas University of Technology
27 Kestucio st., LT-44025 Kaunas, Lithuania
email: vidmantas.nenorta@ktu.lt

Abstract. In this work there is presented a non-traditional graphical approach for the generation of 3D spline path inside the Mechanical Desktop system according to the followers' displacement diagrams in two (X and Y) directions. This spline simulates the cutter path motion (cams profile guide line) on the designed cam profile. It can be used in various computer aided design systems to design 3D virtual cams objects and in computer numerical control part programs to machine the cams. The designed Mechanical Desktop subsystem and its technique offer a practical and straight approach to the special problem solving by means of graphical-programming way and is used for the learning process in 3D modelling.

Key Words: AutoLISP, cams, CAD/CAE/CAM, 3D curves.

1. Introduction

Today's economics requires a high quality product, which would be created decreasing the production time and material resources. The rise of the quality, while reducing the product price, minimizing the time assigned for the design and manufacturing process, is possible only through the employment of the front edge CAD/CAM/CAE (automated design, manufacturing and engineering) systems [1]. These systems works with 3D parameterized models. The parametrical modeling allows to change the parameters of the modeled object at any stage of design process, generate the difference variations of product. This is made through modification of model parameters and automatic creation of detail drawings. Applying the "object oriented" automated design systems it is possible to reduce the costs for experimental prototypes by evaluating the quality of virtual models with CAE systems and to eliminate inaccuracies before producing of the first samples. It is also possible visually evaluate the influence of certain changes to the structure and parameters of product also ensuring the quality and fast presentation of the new product for the market.

Design process of the complex surfaces are closely related with 3D points and curves generation on the space, its right orientation with respect to datum surface. The modeling process can not be executed accurately without mathematical calculations, extractions an appropriate data's from the diagrams and other.

The designed subsystem offers a practical and straight approach to the special problem solving by means of graphical-programming.

2. Cam profiles creation with Mechanical Desktop system

The cam is a specially shaped piece of metal or other material arranged to move follower in a controlled fashion. Cam-follower systems are an extremely important and ubiquitous component in all kinds of machinery. It is difficult to find examples of machinery that do not use one or more cams in their design. Currently, it is virtually universal and also very economical to use computer-aided engineering and design techniques to create cam geometry and make the cam with high precision [2, 3].

ISSN 1644-9363 / PLN 15.00

Cams can be conveniently classified into two main groups:

1. Cams that impart motion to the follower in a plane in line with the axis of rotation of the cam (as does a cylindrical cam);
2. Cams that impart motion to the follower in a plane at 90 degrees to the axis of rotation, as with face or edge cams. Most cams fall into this category.

Inside Mechanical Desktop software the cam calculation and design subsystem is present. However it does not allow create 3D virtual objects of cams. The follower movement is periodical (follower runs up and down, the start and end point of follower are coincide).

We created a special subsystem adapted to Mechanical Desktop system which allows to create cylindrical cam with impart motion to the follower in a plane in line with the axis of rotation of the cam in two different directions (axial X and radial Y). So that category of cam covers both groups of the classification presented over.

The follower motion must be presented graphically with a displacement diagram, inside which all peculiarities of follower movement are reflected (size of movement, velocity, acceleration). In Figure 1 the followers' motion graphics are presented. The motion laws in X and Y directions are independent. It is interdependent only on rotation number (rotation angle) of the cam.

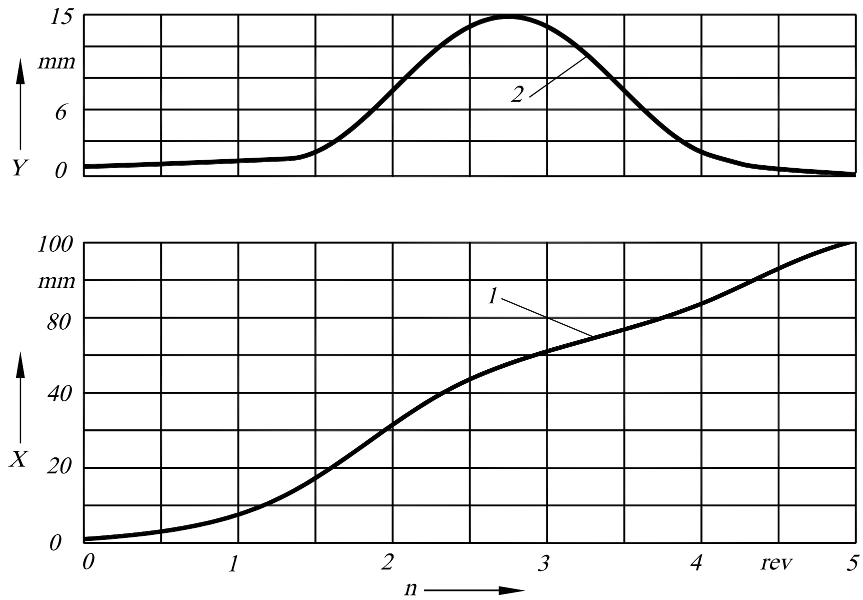


Figure 1: Follower's displacement law in X and Y directions

So the cams' motion law can be expressed by means of the equations:

$$\begin{cases} y = f_1(\varphi), \\ x = f_2(\varphi), \\ \varphi = \omega t; \end{cases}$$

Where: $\omega = \dfrac{\pi n}{30}$ – circular frequency; t – time; n – rotations; φ - rotations angle of cam; x,y – motions of the follower respectively in axial and radial directions.

Over modeling process a special AutoLISP program was created [4]. The program allows scan the diagrams presented in the Figure 1 with required accuracy; setup unlimited number of the points on cams 3D spline path by one revolution of last one. The points on 3D spline path coincide with an impart motion law of the follower in X and Y directions. The scanning process executes in graphical-programming way. Over AutoLISP program creation process we identified the scale factor in the diagrams, analyzed internal graphical data base of

Mechanical Desktop system. DXF code analysis was done in order to extract the information concerning the drawn and temporary used graphical objects, for the creation of new data lists with the required information. The scanning process is independent of the type of the curves used in followers' displacement law diagrams (Figure 1). The diagrams have to be continuity, without any breaks inside. The algorithm used for the program creation can be adapted to the systems with different circular frequency, for modeling of all types of cams used in the practice. Under design process, for the follower's displacement law creation, we can, partially, use integrated standard Mechanical Desktop subsystem for cam creation.

The algorithm of cam profile creation (3D spline path) presented in the Figure 2.

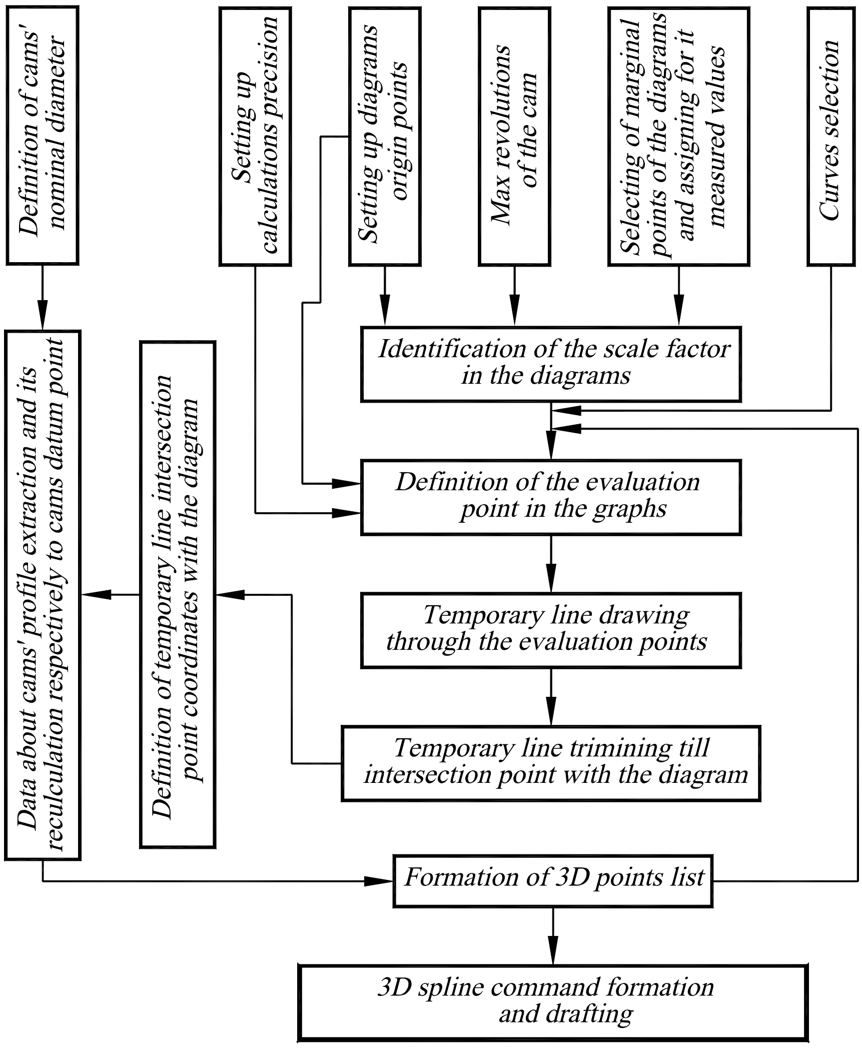
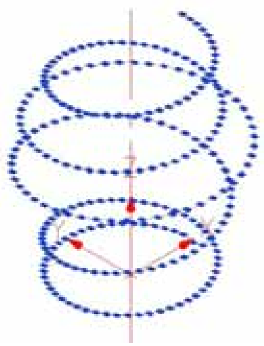


Figure 2: Programs' algorithm

The result of the solution presented in the Figure 3. In those drawings you can identify the points are calculated for the 3D spline path creation accordingly the data presented in the Figure 1 and the cams' model designed according 3D spline.

The presented algorithm and design methodic can be used for creation of any complicated shapes in 3D space. Just you need to depict surface of the designed object graphically or by means of equations.

Using described methodic and technology we can trippingly change and modify the cams' geometry and followers' displacement law, optimize created object by interactive way. There are wide possibilities of the visualization of the created object.



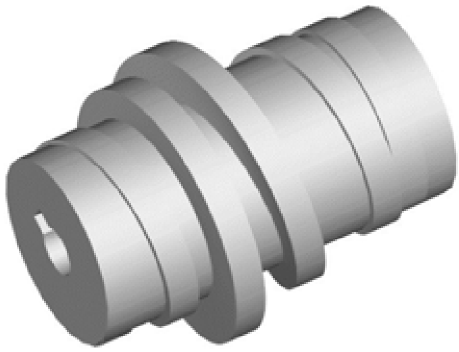


Figure 3: 3D spline and virtual model of the cam

In the world you can find the special software's assigned for cams design. Analytix/Cams, DYNACAM for example. DYNACAM program solves the kinematics and dynamic equations for cam-follower systems. Radial, linear, and barrel cams with either translating or oscillating followers can be designed. Unfortunately it is special and expensive software, which can not be widely used and adapted today. We have solved an existing problem with the software widely used on the design process in the world. We extended its possibilities for special task solving using programming way.

3.Conclusions

In this paper we presented a non-traditional graphical approach for the generation of 3D spline path inside the Mechanical Desktop system according to the followers' non-linear displacement diagrams in two directions which allows extend system's possibilities and save a time assigned for complicated surface design process.

References

[1] *CAD/CAM/CAE observer*. International analytic magazine, 2004-2005 Riga, Latvia, ISSN 1407-7183.

[2] Norton R.L.:*Cam Design and Manufactoring Handbook*. 2001, 7 3/8 x 9 1/4, Hard, Illustrated, 640 pages, ISBN: (0-8311-) 3122-5.

[3] Neff G.P., Zahraee M.A., and Higley J.B., *Computer-Aided Kinematic Analysis of Flat disk Plate Cams: A Reverse Engineering Approach*. Proceedings of the 1995 ASSE Illinois/Indiana Section Conference, West Lafayette, IN, March 16-18, 43-47.

[4] *AutoCAD release 2002 Customization manual.* Autodesk, Inc 2002, 875p.

PROJEKTOWANIE LINII PROWADZĄCYCH O PROFILU KRZYWKI W SYSTEMIE MECHANICAL DESKTOP

W pracy omówiono nietradycyjne formowanie trajektorii 3D „spline" w systemie Mechanical Desktop, wykorzystujące nasuwanie się wodzika w dwóch kierunkach graficznych. Sformułowana krzywa przestrzenna odpowiada trajektorii profilu krzywki. Może to być wykorzystane w wielu systemach projektowania CAD. Proponowany podsystem Mechanical Desktop daje możliwość praktycznego rozwiązywania specjalnych problemów technicznych przy wykorzystaniu modelowania graficzno – programowego.