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Design modeling and motion simulation of disc cam mechanism based on Adams

Yang Chen[1,*], Shuai Li [2] and An Mu[1]

[1]School of Mechanical and Electrical Engineering, Chengdu University of Technology, Chengdu 610059, China

[2]School of Nuclear Technology and Automation Engineering, Chengdu University of Technology, Chengdu 610059, China

*Corresponding Author

Abstract

The disc cam is a component with a complex contour, and the shape of its contour determines its motion law. Designing an appropriate contour curve can make the push rod achieve the expected motion law. Based on Adams, this paper studies four modeling methods and conducts simulations to draw displacement, velocity, and acceleration curves, which provides a reference for modeling and motion simulation of the same type of parts.

Keywords

Adams, Disc Cam, Modeling, Motion Simulation.

1. Preface

The disc cam is the basic form of the cam. The disc cam has a simple and compact structure, a small number of constructions, and a short kinematic chain, which can enable the follower to achieve various expected motion laws. It is widely used in textiles, printing, food, transportation, and machinery. Transmission and other fields. In order to improve the design and manufacturing accuracy of the disc cam mechanism, shorten the design cycle, and observe whether the motion state meets the work requirements, this article uses Adams to summarize four different modeling methods, and conducts model construction and modeling for cam mechanisms with different accuracy requirements. simulation. Through the post-processing data of the software, it can be adjusted according to the needs to make the designed cam mechanism reach an optimal state.[1]

2. Design and analysis of parts structure of disc cam

The disc cam mechanism is a high-end mechanism composed of three main components: cam, push rod and frame. The shape of the cam is an important condition that determines the movement of the push rod. The Adams design process is shown in Figure 1.

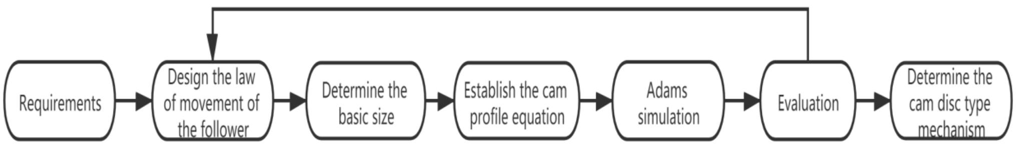

Figure 1 Adams design process

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3. Four design modeling and motion analysis of cam

Direct modeling method, this method has greater limitations and is suitable for mechanisms with relatively regular cam contours. For a model with a simple outer contour, as shown in Figure 2.

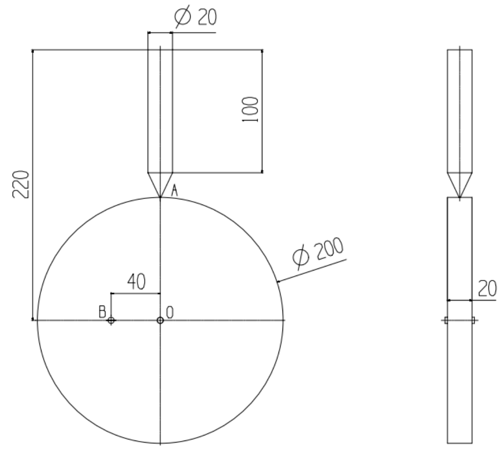
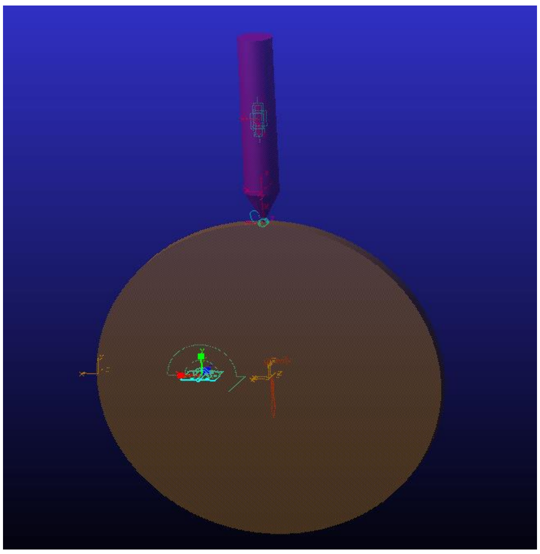


Figure 2 Disc cam

Now that the structure model of each part is established in Adams software, when establishing the cam contour line, it is necessary to pay attention to that, first create a circular line, and then form a cam by pulling up the command. When defining the cam motion state later, it is convenient to define a point-line contact . In order to make the cam circle transition smooth, in the geometry modify curve circle dialog box, increase the corresponding value after segment count. The model building of the push rod can choose the boss command in solids, the top radius is defined as 0.1mm, and other values are shown in Figure 2. After the model is built, define the constraints and drive of the cam. Point B of the cam is defined as a rotation pair, the push rod defines a translation pair as a whole, and the contact constraint of point A is first defined at the top of the push rod, and point-curve constraint is selected. command. Point B is defined as the driving point, and the speed is 1d/s for simulation.



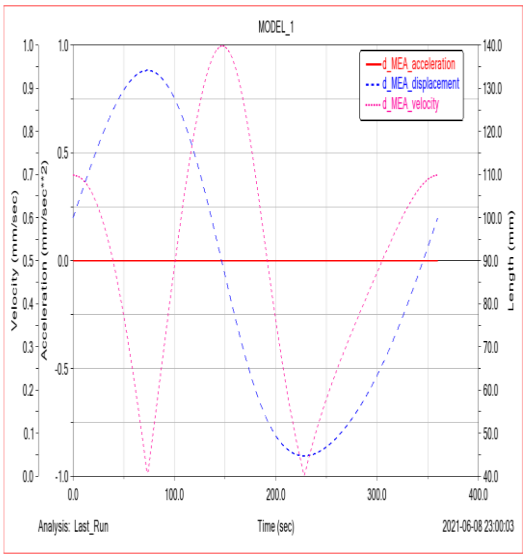


Figure 3 Adams three-dimensional model Figure 4 Adams post-processing diagram

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3.1. CAD software model import method

The high-precision modeling of the cam profile in this method often requires high user requirements. First, the cam is modeled in CAD software, and finally imported into Adams to define constraints and simulate. This article briefly introduces the outer contour creation form in UG, as shown in Figure 5, the simulation will not be repeated.[2-3]

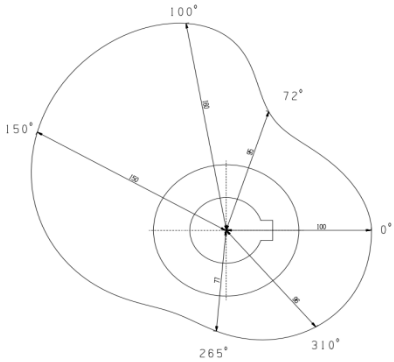
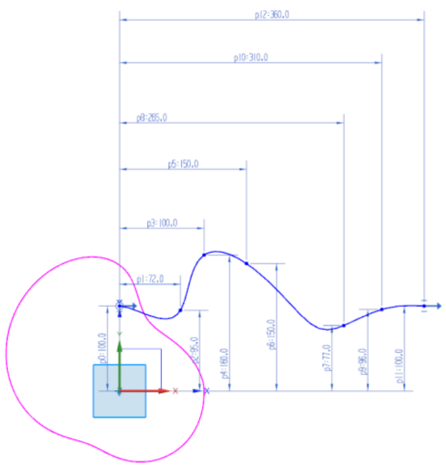


Figure 5 Cam profile

According to the requirements in Figure 5, the art spline curve was first drawn to complete the creation of the variable radius curve. At the same time, in order to avoid sharp points appearing in the stretching body, tangent constraints were placed at the ends of both ends. Then create a helix, where the radius is the art spline curve as the regular curve, the pitch is set as 0, and the number of turns is set as 1. Select the right rotation to complete the creation of the CAM contour curve, and then the 3D model effect as shown in Figure 7 can be presented through pulling and lifting and more details processing.



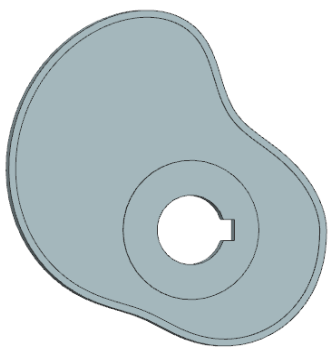


Figure 6 UG sketch art spline and helix creation Figure 7 Three-dimensional model of UG cam

3.2. Generating locus method

Can use the trajectory of the generation point in ADAMS to determine the CAM contour, this method is more accurate, close to the practical application. [4] In the process of generating trajectories, simple rules can be realized by driving functions, while complex motion rules can be realized by means of new simulation script created by Adams/ Solver. Here, the latter is chosen for modeling and simulation analysis. The case is shown in Table 1.A disk-shaped CAM mechanism with a pair of straight moving roller push rods is provided. The working conditions are high speed and light load. The movement requirements of push rods are shown in the table below:

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Table 1 Push rod movement requirements

Pushing course Angle	Far rest Angle	Return Angle	Near rest Angle	Pushing course H
90°	90°	60°	120°	15mm

According to the principle of mechanical refers to the type, the primary CAM base circle radius r = 50 mm, the push rod roller radius r = 10 mm, high speed light load working conditions, choose the maximum acceleration and jerk maximum smaller motion law, putting in place to ensure that work smoothly and precision, therefore case choose sine acceleration motion law of push rod, return to choose five times polynomial motion law. [5]

1)The push rod stage: $c_1 = \pi / 2$

$$s_1 = h\left[\frac{2}{\pi}\theta_1 - \frac{1}{2\pi}\sin(4\theta_1)\right] \qquad \theta_1 = \left[0, \frac{\pi}{2}\right]$$

2)The far rest stage: $c_2 = \pi / 2$

$$s_2 = 15 \qquad \theta_2 = \left[0, \frac{\pi}{2}\right]$$

3)The return phase: $c_3 = \pi / 3$

$$s_3 = \frac{10h}{c_3^3}\theta_3^3 - \frac{15h}{c_3^4}\theta_3^4 + \frac{6h}{c_3^5}\theta_3^5 \qquad \theta_3 = \left[0, \frac{\pi}{3}\right]$$

4)The far rest stage: $c_4 = 2\times\pi/3$

$$s_4 = 0 \qquad \theta_4 = \left[0, \frac{2\pi}{3}\right]$$

After the selection of basic size and motion rules is completed, the model is established in ADAMS and the simulation analysis is carried out. The main process is shown in Figure 8.

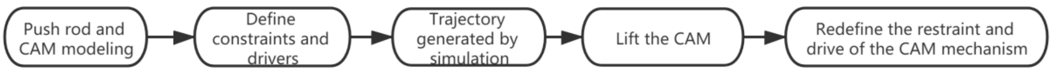

Figure 8 Trajectory method flow chart

First, establish the model of the push rod in ADAMS, and then draw an auxiliary rectangular plate. Let the rectangular plate rotate, and the push rod moves up and down with the movement of the rectangular plate, then a CAM contour curve can be drawn on the rectangular plate. The dimension definition of the rectangular plate only needs to satisfy the final trajectory line on the rectangular plate. Define the constraints, define the rotating pair at the center of the rectangular plate, define the moving pair of the push rod moving up and down, define the rotating pair of the rectangular plate driving, and define the movement law of the push rod. Create a new post-processing simulation script file, and enter a function that is consistent with the case in the Adams Solver Commands dialog box. The specific content of the simulation function is as follows:

```
! Insert ACF commands here:
!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!
!PushPreocess
MOTION/2,FUNCTION=15*((2*TIME*(PI/180)/PI)-sin(4*TIME*(PI/180))/(2*PI))
SIMULATE/KINEMATIC, END=90,STEPS=1000
!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!
```

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```
!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!
!RemoteRest
MOTION/2,FUNCTION=15
SIMULATE/KINEMATIC, END=180,STEPS=1000
!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!

!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!
!BackProcess
MOTION/2,FUNCTION=15-270*15*(TIME*(PI/180)-
PI)**3/(PI**3)+1215*15*(TIME*(PI/180)-PI)**4/(PI**4)-1458*15*(TIME*(PI/180)-
PI)**5/(PI**5)
SIMULATE/KINEMATIC, END=240,STEPS=1000

!NearRest
MOTION/2,FUNCTION=0
SIMULATE/KINEMATIC, END=360,STEPS=1000
```

Through the simulation of the above script file, the rectangular plate moves relative to the push rod, establishes a point at the lower end of the push rod, uses the trance point's relative position from last simulation command to generate the trajectory of the CAM curve, and then carries out stretching operation on the trajectory. Remove the auxiliary rectangular plate, and the model is shown in Figure 9. Finally, the line contact between the CAM and the push rod is defined for simulation and post-processing, and the curves of displacement, velocity and acceleration as shown in Figure10 are obtained.

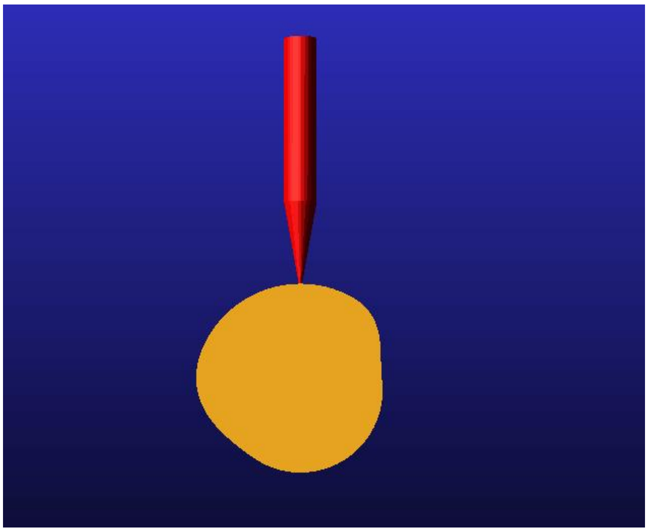

Figure 9 Model diagram of trajectory method

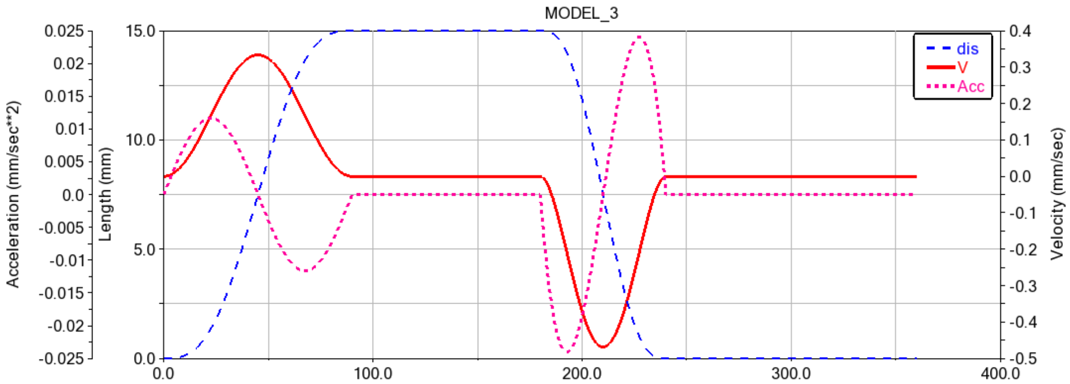

Figure 10 Post-processing curve of ADAMS with trajectory method

3.3. CAM function library generation method

This method uses CAM function library in ADAMS to generate Cam mechanism directly according to parameter selection and definition. For the disc CAM mechanism with simple shape, it is more efficient, but for the definition of complex curve, there is a large deviation in precision. CAM function library method is mainly divided into three steps: defining push rod motion law, generating Cam contour curve and generating complete Cam mechanism, which can be directly simulated. The detailed process is shown in Figure 11.

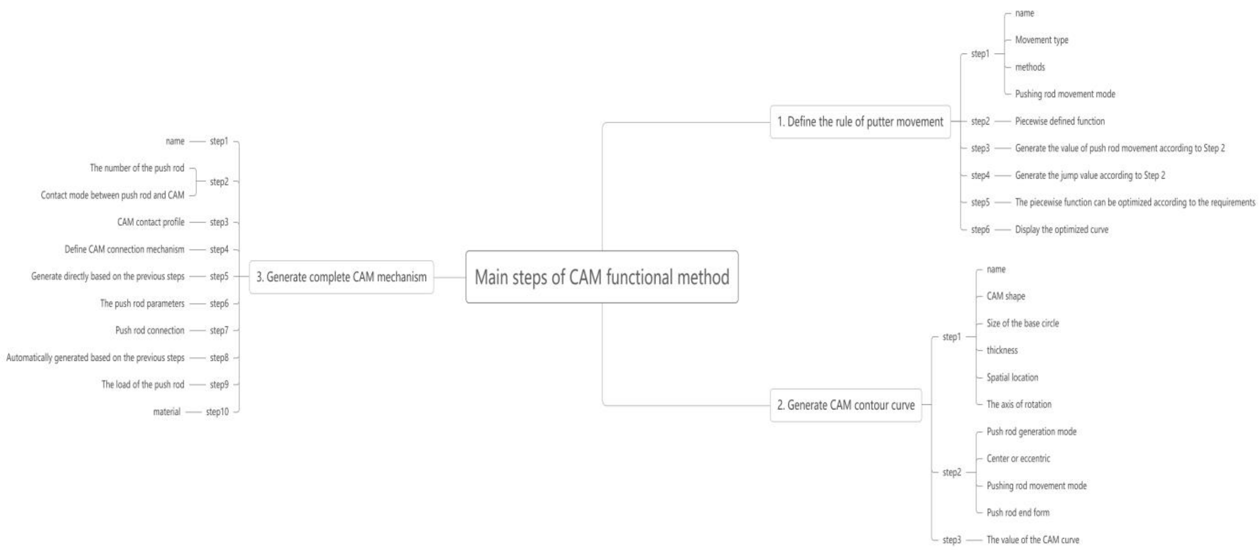

Figure 11 Detailed step flow chart of CAM function library generation method

4. Conclusion and Prospect

In this paper, four different modeling methods, including direct modeling method, CAD software model import method, path generation method and CAM function library generation method, are studied by using the ADAMS View 2018 module in ADAMS. At the same time, the simulation function of ADAMS is used to check the motion state of the built model, which provides a reference for the modeling and simulation of the same type of parts.

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