The Design of Parallel Combination for Cam Mechanism

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Abstract

This is a combined design of type II of parallel mechanism, which is used to realize arbitrary trajectories by the combination of cams mechanism. The combined cams mechanism and the method of using analysis to design it, and establishes cam’s mathematical expression through analysis method. Then can show the opposite moving relation between input component and output component, in order to design moving tracks and cam’s outline. Also designs system’s total flow chart. Illustrates arbitrary moving tracks’ combined organization’s program design and method, the result of program’s execution and so on through combine program and interface method. uses animated imitation to test and verify the design’s result. The whole program’s process holds mechanical innovation as its foundation, it take the VB as a developing platform. Adopting module design to realize arbitrary trajectories, the design’s result achieves the desired results.

Keywords: Simulation technology; Parallel combination; Arbitrary trajectories; Cam mechanism; Mechanism Design

Introduction

With the development of the mechanization and automation of the production processing. It is the higher demand of the characteristics of movement of bodies and power for output of the mechanism, but the single basic mechanism has some limitations, it can not meet certain performance requirements, more and more demanding requirements of movement trajectory of mechanism in the project, such as the control mechanism, compound feed mechanism etc. Because of the reasons of design, processing and installation etc. On many occasions, the equipment can not be fully realized designer’s intent, People have to adopt the approximate the trajectory. The demand for high precision, complex movement is getting more and more, with the continuously progress of machining capacity. Especially in the processing of some small and sophisticated components, this job will require very precise trajectory of the cutting tools. So there are the urgent requirements of the realization movement trajectory for the mechanism design. Therefore, it is
urgent task of enhancement the mechanical innovation and accelerates the pace of innovation machinery to 
meet the needs of our daily processing for the machinery industry. [1-5]

The basic mechanism generally includes connecting rod, cam, gear, intermittent, etc. Although these 
basic mechanisms are very broad for the application, but they all have also some limitations, for example. 
Linkage mechanism must be to solve the balancing problem for the high-speed running, some special law 
of motion with a single linkage is also difficult to achieve. The cam mechanism can receive the arbitrary 
law of motion, but the trip is not adjustable. The gear mechanism has good characteristics of movement and 
dynamic, but the mode of motion is simple. Ratchet mechanism, geneva Mechanism and other intermittent 
are not ideal characteristics of kinematic and dynamic, with the inevitable shock, vibration, and fluctuations 
in velocity and acceleration, etc. To solve these problems, the need for innovative design, full use of the 
good performance of the basic institutions, improve their bad characteristics.

The mechanism innovative is many ways, composition, evolution and variation, tectonic movement 
chain, and regeneration, etc. Which the combination theory can usually meet the requirements of trajectory, 
but also has good movement and dynamic characteristics, and make up for the shortcomings of a single 
mechanism. The mechanism characteristic can be more perfect, more diverse forms of movement after 
combination. [6]

**Combination mechanism**

Combination mechanism can be divided into series connection, parallel, composite and stacking 
combination, etc. which parallel combination mechanism can constitute a new type with two or more 
parallel arrangement, composite combination mechanism can also constitute a new type with a two degrees 
of freedom and an additional by the method of parallel arrangement. Usually it can utilize the commonly 
method to realize motion trajectories, with combination of different types. [7]

I type of parallel combination: The principle of parallel mechanism combination is the basic institutions 
of two or more parallel arrangement, the basic mechanism has its own input, an output component. This is 
equivalent to the synthesis of movement, its main function is to t the output component form of supplement, 
strengthen and improve, etc. The diagram of pass the following of motion is shown in Fig 1.

![Fig. 1 Transmission diagram of parallel combination mechanism for I type](image)

II type of parallel combination: It has the common basic structure of each input and output components 
for the II type, it can separate one movement into two movements, then make the two movements into one 
to out of movement. Its main functions are similar with the parallel combination of type I, to change the 
output state and trajectory of motion. Also can improve stress state agencies, improve their own balancing. 
The diagram of pass the following of motion is shown in Fig 2.

![Fig. 2 Transmission diagram of parallel combination mechanism for II type](image)
Fig. 2 Transmission diagram of parallel combination mechanism for II type

III type of parallel combination: Mechanisms have the common input, but have their own output, it can separate one movement into two movements, it’s main function achieve the two movement output, which the two movements joint function each other to complete the more complicated process action. The diagram of pass the following of motion is shown in Fig 3.

Composite mechanisms of combination

This is a kind of combination modus with two degrees of freedom A and B hen an additional mechanism. This is a more complex combination type, the basic bodies have movements of the two inputs, one from body structures, and the other from the additional mechanism. There are two cases from the additional input, one is the body with additional components and access; the other is connected back through additional mechanism. [8-9]

The type of parallel: Taking the component from the mechanism of based and additional into parallel connection, and also taking the linkages linked from them into parallel connection, one of linkages linked as input, then another linkage linked of basic component as output, the diagram of motion transfer is shown in Fig 4.
The two linkages linked join with the parallel manner from components of the basic and additional, the other the linkages linked let the motion loop join the basic component to the components with complex motion. The diagram of motion transfer is shown in Fig 5.

![Diagram](image)

**Fig.5 Transmission diagram of loop join of combination mechanism**

**Case Study**

Building equation: There are two cams to complete the movement in a certain direction, the cam 1 complete the movement in X direction, the cam 2 completes the movement in Y direction. First respectively designed the two basic cams, then the combination cam mechanism can realize the purpose of any trajectory by the coordinating activities. The schematic diagram of straight moving follower disc cam is shown in Fig 6.

![Diagram](image)

**Fig.6 The schematic diagram of straight moving follower disc cam**

As shown the Fig 6. In the Cartesian coordinates, the coordinates of the point in the cam profile can express as:
\[ x = KN + KH = (s_0 + s) \sin \phi + \cos \phi \]

\[ y = BN + BH = (s_0 + s) \cos \phi + \sin \phi \]  

(1)

Where, \( e \) is eccentricity, \( s_0 = \sqrt{r_b^2 + e^2} \)

Because of the cam 1 and cam 2 is disc cam of linear motion along the axis, and then:

\[ e = 0 \]
\[ s_0 = r_b \]  

(2)

Therefore, the above equation can be written as

\[ x = (r_b + s) \sin \phi \]
\[ y = (r_b + s) \cos \phi \]  

(3)

Consider the impact roller; the equation of the actual profile is follow.

\[ X = x \mp r_r \cos \phi \]
\[ Y = y \mp r_r \sin \phi \]  

(4)

Where \( r_r \) is the roller radius, the symbol negative is the internal offset curves, the symbol positive is the external offset curves.

The \( \theta \) can gain from:

\[
\begin{align*}
\tan \theta &= -\frac{dx}{dy} = -\frac{dx/d\delta}{dy/d\delta} \\
\frac{dx}{d\delta} &= \left(\frac{ds}{d\delta} - e\right) \sin \delta + (s_0 + s) \cos \delta \\
\frac{dy}{d\delta} &= \left(\frac{ds}{d\delta} - e\right) \cos \delta + (s_0 + s) \sin \delta
\end{align*}
\]  

(5)

It not only can greatly improve the design speed, accuracy and design automation design, but also apply the simulation technology and modeling technology to analyze three-dimensional dynamic, by the parallel composite design of the cam mechanism. The cam base circle radius of 1, 2 and the corresponding coordinates of points is shown in Fig 7.
Fig. 7 Data display window

Click the start button can enter the interface window of animation, to continue the animation, and then click this button. To exit the animation interface, click exit. It is the all simulation process.

Summary

The design take Ill type of parallel combination of the mechanical of innovation system as theoretical basis, base on the development platform of VB language, it can realize dynamic simulation for the cam mechanism by the compile program, the building system can gain the parametric design and motion simulation of arbitrary trajectories of cam mechanism.

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