**Scientific Research**

# Motion Modeling and Simulation Technology of Packaging Executive Mechanism

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**Abstract:**  Based on the analysis of the kinematics diagram of mechanism concerning Packaging Executive Mechanism, the three -dimension model of it was established by Pro/E software the motion modeling technologies and methods of Packaging Executive Mechanism are researched by using the Mechanism/Pro module of Pro/Engineer software the Simulation results are an analyzed and show the feasibility and rationality of Packaging Executive Mechanism.

**Keywords:** Packaging executive mechanism; kinematics simulation; virtual prototype

## 1. Introduction

In packaging machinery, wrapping operations, such as pushing, folding, gluing, heat sealing and cutting are completed by wrapping executive mechanism. The mechanism, for example, pushing rod and heat-sealer often make the reciprocating linear or arc movement, sometimes rotation or plane curve movement, as well. Linkage or cam is generally chosen as the executive mechanism which makes reciprocating movement. The characteristics of linkage include: all kinematic pairs being surface contact, light contact stress, long service life, easily processed, reliable, and low noise. So it has been increasingly applied in wrapping machines.

Wrapping executive mechanisms are commonly designed by geometric drawing method which is complex and poses heavy calculations and is not conducive to be improved, while the simulation technology is an effective means of testing. During the mechanism developing process, simulation is used to analyze primarily-designed mechanisms to check the correctness, rationality of mechanism movements, to check whether there are interferences among the parts and whether the mechanism movement can reach its requirements so that the design can be improved. This paper carried out a simulation study on the mechanism movement of the pushing part of the wrapping executive mechanism by using Pro/Engineer.

## 2. Simulation Process

After the modeling and assembling the pushing part of wrapping executive mechanisms by Pro/Engineer, the simulation can be directly converted to mechanism motion simulation model. Mechanism / Pro in the simulation shown in Figure 1.
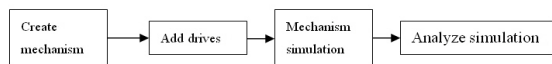


Fig1.the process of kinematics simulation

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### 2.1. Create Mechanism

Figure 2 is pusher mechanism structural drawing, consisting of the crank AB, arc-type linkage CD, pushing rod and other components. After modeling all the parts of the pusher mechanism, the connection method is used to add components in the assembly to define the relative motion between them. The connection information is stored in the assembly file by Pro / Engineer, which indicates that subassembly parts inherited parents' assembly parts in the connection definition, that is, when there is no relative motion between components, placement of the assembly can be used to fix the relative movement. In the Pro / Engineer mechanism environment, the added mechanism model tree shown in Figure 3.
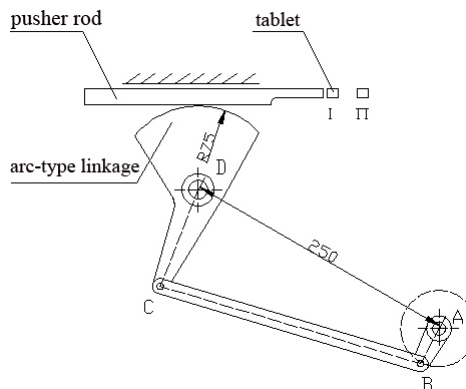


Fig2. Kinematics simulation of pushing equipment

The pusher part of the wrapping executive mechanism is made up of the crank-rocker mechanism and arc-type linkage, and the arc-type linkage is connected by the gear and rack, so when entering the mechanism simulation interfaces, the gear is added. To speed up the movement of the simulation, a simple structure simulation is made on the base part of the pushing mechanism.

### 2.2 Add drives

The dialog box of adding gear definition is shown in Figure 4, because it is the connection of fan gear and rack, the connection type is rack and pinion mode. To improve simulation speed, tooth structure of the gear is not drawn in the modeling, and pitch circle diameter can be equivalent to that connection. The pitch circle diameter of fan gear in the figure is 150mm.
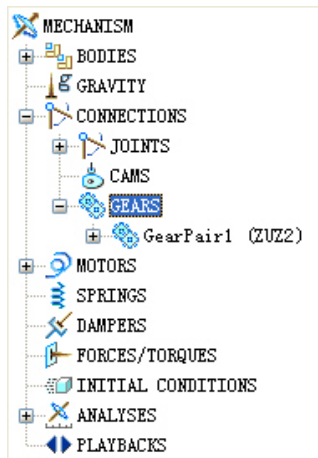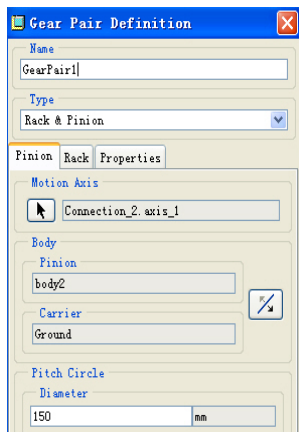


Fig 3.model tree of mechanism



Fig 4.the definition of gear connection

After all the mechanisms were added, the movement source should be added. There is only a power source at the crank in the pushing, so a servo motor is added at the crank junction, the speed is set at $60^0/s$.

## 2.3 Mechanisms simulation

After adding all of the mechanisms and power sources, a motion simulation is carried on.The pusher motion simulation diagram is shown in Figure 5

Finishing the above steps, it can start the motion simulation. At first, define the motion simulation which includes define simulation time, frame number, as well as the beginning and ending time of the electric motor, etc. The dialog box of the definition analysis is shown in Figure 6. After the motion simulation, the output volume can

be defined. Mechanism／Pro can provide rich volumes, such as displacement, velocity, acceleration, constraining force, etc. The evaluation method provides each time step, maximum, minimum, and root mean square, etc.
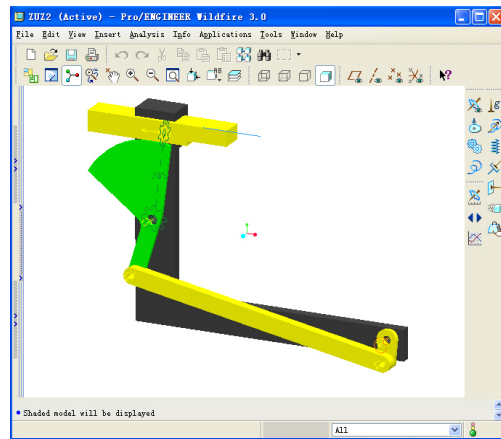


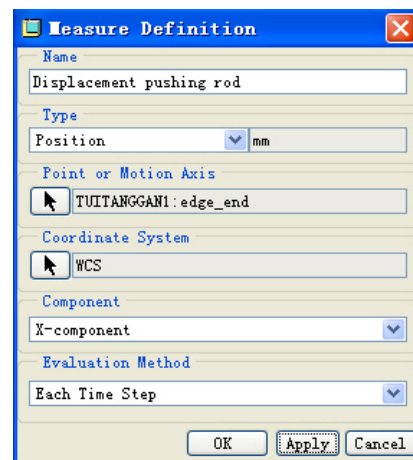Fig5. Kinematics simulation of pushing equipment



Fig6.the definition of measure output

This article defines the displacement of the end of the pushing rod, velocity and acceleration, and coordinate system is the default WCS coordinates, assessment methods is for each time step. after output was defined, the output can be calculated in accordance with simulation results, For the purpose of comparative analysis, it can choose to generate the different measurements in the same coordinate graphical interface which can also be generated separately. This paper explores pushing rod displacement, velocity and acceleration output generated in the interface of different materials. The graphics is shown in Figure 8,9 and 10

## 3 Simulation result

From the figure, pushing rod displacement curve can be seen that the pusher way of the pushing rod is 27.15mm,
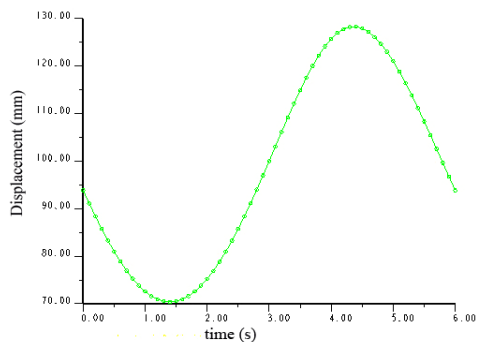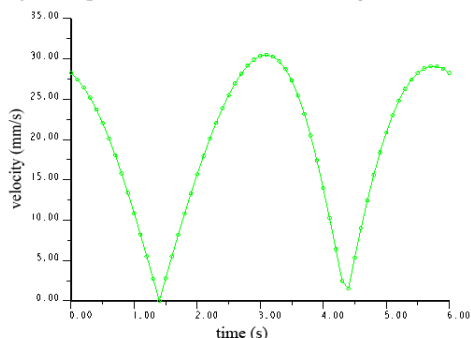
Fig8. Displacement curve of pushing rod
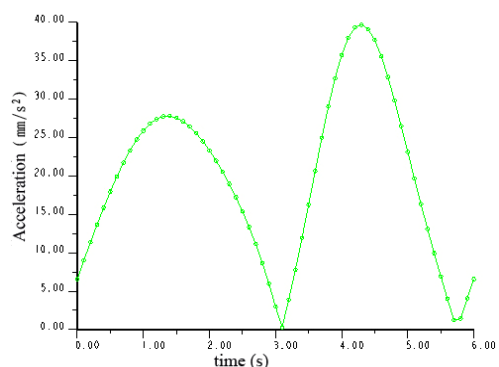


Fig9.Speed curve of pushing rod



Fig10. Acceleration curve of pushing rod

which meets the design requirements. When Time t was 4.4 seconds, pushing rod moved to the outer limit position, and velocity was zero, and acceleration reached its maximum. When Time t was equal to 1.4 second, pushing rod moved to internal limit location, speed was zero.

By motion simulation, the theoretical calculation is verified, which also meets the design requirements.

In order to verify the correctness and rationality of the design, this paper presented the motion modeling simulation on the pushing part of the wrapping executive mechanism and simulation data for analysis by applying computer modeling and simulation technology after the wrapping executive mechanism program and structural parameters of the design were completed. The design can be verified through the simulation, it achieves good results, and ensures the design quality. At the same time, modeling, assembly and simulation are finished by the same software, which makes parameter change easy, and help reduce data loss created by the conversion of file format and improve the design efficiency.

## 4 Conclusion

By analyzing the pushing part of the wrapping executive mechanism, and using the powerful modeling and assembly capabilities of Pro / Engineer design software to complete the mechanism's three-dimensional modeling as well as virtual assembly, and realize the motion simulation study in the body of each component in the motion simulation module of the mechanism . The results show that it can simulate the movement of the pusher by a reasonable use of dynamic simulation technology and can clearly see their law of motion, therefore, providing a theoretical basis for the design and improvement of the pusher, which helps to shorten product design cycle, reduce product development costs, and improve product capacity to respond quickly to market changes.

## References

[1] ZHOU Xian ,WANG Fang, Reverse Kinematics Regulation of Gripper Opening and Closing Mechanism of Single Sheet Offset Press[J],Packaging Engineering,2009

[2] Li Haixu, Qu Xiangju, Wang Weijun, Multi-body Motion Modeling and Simulation for Tilt Rotor Aircraft. Chinese Journal of Aeronautics[J], Volume 23, Issue 4, August 2010.

[3] Haug E J, Computer Aided Kinematics and Dynamics of Mechanical System, Volume1: Basic Methods[M] .Boston , Allyn and Bacon , 1989.

[4] LI Rui-qin,ZOU Hui-jun, Five Methods for Modern Mechanism Creative Design. Mechanical Science and Technology[J], 2003.