Design and Simulation of Swing Handing Machine

Yan Zhao [a], Hui Kang [b] and Yue Guo [c]

College of Electrical and Mechanical, Shandong University of Science and Technology, Qingdao Shandong 266590, China.

[a]364636770@qq.com, [b]814918574@qq.com, [c]1006754714@qq.com

Abstract

Today,efficience and quickness are demanded, and the demanding of modern industrial manufacturing and processing industry for transport become more and more high. The small pallet is gradually becoming the darling of factory production and is used on different occasions. The main work of this graduation design is to design the size of the structure of the handling machine ， and using VB to programm the language, so the mechanisms movement process is showed.

Keywords

Swinging handling machines;Motion analysis;Visual Basic.

1. Introduction

Swing conveyor is a machine that moves and transports goods and workpieces in production. it is a kind of mechanism that is often used in factory production. In recent years, the development trend of swing transporters is mainly to adopt new technologies and concepts to carry out innovation and transformation so as to make them think about intelligent and automatic development. In this paper, kinematics is mainly used to analyze the swing conveyor, and dynamic and static force analysis is carried out on the structure of the connecting rod, and motion simulation is carried out to simulate the motion process of the swing conveyor.

2. Working Principle and Analysis

2.1 Working Principle and Structure of Swing Conveyor

The working principle of the swing conveyor is to push the worktable to move through the swing of the connecting rod mechanism so as to realize the conveying function. It mainly consists of an executive part, a driving part and a control part [1]. The executive part is mainly a connecting rod mechanism and a sliding block; The driving part refers to the operation of the motor to drive the connecting rod to operate; The control part mainly refers to the rheostat of various switches, and the various parts of the swing conveyor operate in coordination with each other to ensure the precision of the mechanism.

2.2 Analysis of Swing Conveyor

The driving force and impedance force are the main forces that mechanical movement receives in the working process. in the system of swing conveyor, the driving force is generated by the motor, while the impedance force is generated by the friction of slide block and other factors [2]. In the working process of the swing conveyor, the driven parts are driven to move by the assembly of the driven parts to carry the objects on the slide block.

3. Design of Linkage Mechanism

According to the working principle of the swing conveyor, draw the motion diagram of the swing conveyor, analyze its motion mode, and respectively calculate the size of the connecting rod [3]. The following Fig. 1 is a schematic diagram of the swing conveyor.

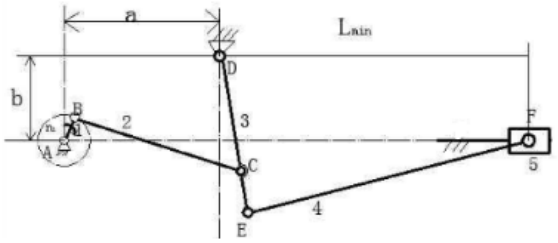

Fig. 1 structural schematic of swing conveyor

As shown in the figure, a is the horizontal distance from point a to point d, b is the vertical distance from point a to point d, lmin is the horizontal distance from the left limit position of the slider to point d, and h is the moving distance of the slider. according to the initial data, the corresponding size can be calculated. The original data are as follows, see Table 1.

Table 1. Original data of the organization

Content	Mechanism design and kinematics simulation of swing conveyor							
Symbol	n	H	a	b	Lmin	Φ1	Φ2	K
Unit	r/min	mm	mm	mm	mm	.	.	.
Option 1	60	1000	500	300	900	70	110	1.5
Option 2	65	1050	520	350	960	65	115	1.7
Option 3	70	1100	530	400	990	60	120	2.0

Because scheme 3 is easier to calculate than other schemes and is closer to the actual life scheme data with the basic data, scheme 3 is selected for design in this design.

When designing dimensions, the data given in this design can be used to calculate. through the cosine theorem of triangle, the length of corresponding rod can be obtained to obtain the length of rod 1 and rod 2, and then the length of rod 3 and rod 4 can be obtained according to the two limit positions of slider sliding. however, before calculation, the rod must be divided into two parts: crank-slider mechanism and crank-rocker mechanism. As shown in the figure below.

A, B,C , D, E can be regarded as a crank-rocker mechanism, in which ab is the driving rod and the rest is driven. C, D, E, F are regarded as a slider-crank mechanism. after being divided into two parts of the mechanism, the cosine theorem can be used to calculate the specific length value of each component.Consider c, d, e, f as one part, as shown in figure 2

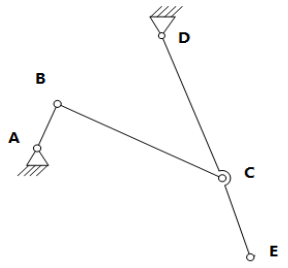

Fig. 2 Crank rocker mechanism

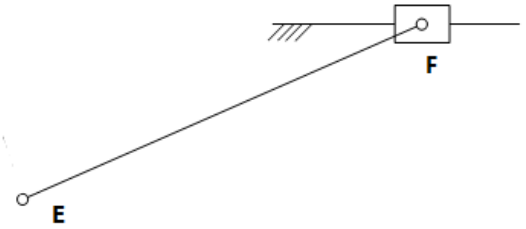

Fig. 3 Crank slider mechanism

We know that,the polar angle is $\theta = 180^\circ (K-1)/(K+1)$,Obtained $\theta = 60^\circ$ and then according to the cosine theorem, the limit position of the bar is analyzed and calculated.The following formula is obtained:

In fig. 3：

$$(BC-AB)^2 = CD^2 + (a^2+b^2) - 2\cos\left(\phi_1 - \arctan\frac{b}{a}\right) \times CD \times \sqrt{a^2+b^2} \tag{1}$$

$$(BC+AB)^2 = CD^2 + (a^2+b^2) - 2\cos\left(\phi_2 - \arctan\frac{b}{a}\right) \times CD \times \sqrt{a^2+b^2} \tag{2}$$

$$4CD^2 \sin^2\left(\frac{\phi_2-\phi_1}{2}\right) = (BC-AB)^2 + (AB+BC)^2 - 2(BC-AB)(AB+BC)\cos\theta \tag{3}$$

The sizes of AB, BC and CD can be obtained：

AB=331mm 、 BC=763mm 、 CD=955mm

In fig. 4：

$$EF^2 = DE^2 + L\min^2 + b^2 - 2DE\sqrt{L\min^2+b^2}\cos\left(\pi - \phi_1 - \arctan\frac{b}{L\min}\right) \tag{4}$$

$$EF^2 = DE^2 + (L\min+H)^2 + b^2 - 2DE\sqrt{(L\min+H)^2+b^2}\cos\left(\pi - \phi_2 \arctan\frac{b}{L\min+h}\right) \tag{5}$$

The sizes of EF and DE can be obtained：

DE=1055mm 、 EF=1600mm

Thus, the overall size of the mechanism can be obtained.

4. Vb Simulation

Vb is used to simulate the movement process of the swing conveyor. in the simulation process, the module of the clock is mainly used for design. The specific design process is as follows:

(1) set the clock cycle

Vb program needs to define the function of the clock for the active ab when it runs, and it can also be regarded as defining the operating speed of the active ab [4].

Private Sub Command1_Click ()

Me.Timer1.Interval = 50 '0 'Sets the cycle of the clock to 500 milliseconds Me.Timer1.Enabled = True

End Sub

set the center height of the drawing board

Before setting the parameter relation of each component of the swing conveyor, position the drawing board and draw a dashed line as the frame of the whole mechanism.

```
Private Sub IniFrmPic (pic As PictureBox)
On Error Resume Next
pic. AutoRedraw = True
TempWidth = AB + a + BC + EF              'Defines the width of the artboard
TempHeight = DE + 100                     'Defines the height of the artboard
pic.Top = Me.Command1.Top + Me.Command1.Height + 200
pic.Left = 100
pic.Width = Me.ScaleWidth - 200
pic.ScaleMode = 3
pic.Height = pic.Width * TempHeight / TempWidth
pic.Scale (0, TempHeight)-(TempWidth, 0)
End Sub
```

After you have set the position of the drawing board and defined various parameters of the assembly, you can enter the angular relationship between each member.

```
If i > 0 And i <= 120 Then
tempSubRightX = AB * 2 + BC + EF - tempTrip * (120 + i)  'Calculates the position of the slider
tempAngle = 300 - 60 / 180 * (i + 60)   'Calculate the swing angle of the rocker
ElseIf i > 120 And i <= 300 Then   'Set the travel minimum at 300 degreestempSubRightX = AB * 2 + BC + EF - tempTrip * (360 - i)
tempAngle = 240 + 60 / 180 * (i - 120)
ElseIf i > 300 And i <= 360 Then
tempSubRightX = AB * 2 + BC + EF - tempTrip * (i - 240)
tempAngle = 300 - 60 / 180 * (i - 300)
End If
```

The final step is to draw the slider, set ab to clear the data after one revolution, restart the running program, and enter the next cycle.

After the program is completed, the motion simulation of the swing conveyor can be realized by running the program. by changing the parameters representing the speed, the running speed of the rod can be adjusted during the running process [5]. Similarly, changing the structural parameters in the source program can also affect the simulation.

When the program is running, through the angle relation between the rod and the original follower, the rest of the follower will change due to the angle change. As shown in the figure below.

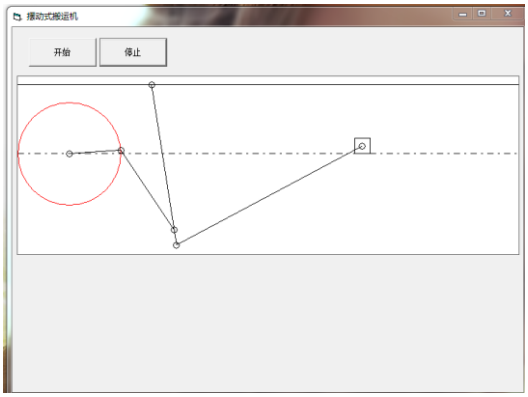

Fig. 4 Vb simulation chart

5. Conclusion

This paper has completed the structural design of the swing conveyor. by dividing the mechanism into three parts, the motion diagram of the swing conveyor is drawn, its motion mode is analyzed, and the sizes of the connecting rods are calculated respectively. Finally, using VB 6.0 software, the motion simulation is carried out, and the motion status of the swing conveyor is analyzed, so as to have a certain understanding of the whole conveyor.

References

[1] Department of mechanical principles and mechanical parts, northwestern university of technology. mechanical principles. 8th edition [m]. higher education press, 2013.
[2] Liu Yi. curriculum design of mechanical principles [m]. Huazhong university of science and technology press, 2008.
[3] Dai Juan. design guide for mechanical principle course [m]. higher education press, 2011.
[4] Bai kangsheng. visual basic programming. 2nd edition [m]. Tsinghua University publishing house, 2012.
[5] Francesco balena, full and accurate group, full and accurate group. visual basic 6 compilation of programming techniques [m]. 2000.