机械原理实验指导及实验报告

Mechanisms and Machine Theory-Experiment Instruction and Report

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Contents

Experiment 1 Mechanisms Recognizing and Kinematic Diagrams Drawing

1. Experimental objectives

1. Establish real sense about concepts of kinematic pairs, parts, links, mechanisms, etc, through the observation and analysis of typical mechanism model.

2. Observe the movement of the driving link and driven links, and the motion transmission mode between them.

3. Master the method of drawing kinematic diagram of mechanisms with the allowed symbols according to the existing mechanism model.

4. Master the method of calculating the degree of freedom of mechanisms. Deepen the understanding the conditions for judgment whether mechanisms have determined motion.

2. Experimental Principle

Since the mechanism motion is only related with the number of links and the number, the type, relative location of kinematic pairs that made from links. The shape and the physical structure of kinematic pairs can be put aside when drawing the kinematic diagram. We could express the kinematic characteristics through using some simple symbols to represent the links and kinematic pairs and indicating the relative position of kinematic pairs according to a certain scale.

3. Experimental Tools

Students prepare a pencil, a ruler, an eraser and compasses.

4. Experimental Procedures and Requirements

Choose a mechanism model and draw its kinematic diagrams. Then record the relevant data on the experiment report.

1. Observe the structure of the mechanism, understand its function and determine the moving links.
2. Slowly rotate the moving links to make the mechanism move. Distinguish each movement unit in order to determine the number of links forming the mechanism.
3. According to the contact between two links and the character of relative motion, determine type and number of kinematic pairs in the mechanism.
4. Take a plane parallel to the body movement as the view plane (plane of projection). Then, adjust the mechanism to a position without overlap for each links of the mechanism.
5. Draw the kinematic sketch diagram on a scratch paper starting from the moving links in accordance with the order of each link connection， using the allowed symbols and simple lines.
6. Calculate the degree of freedom of the mechanism. Judge whether the mechanism has determined movement and contraste with

mechanism model, observe whether they matched.

7. Measure length dimension and mutual position between two kinematic pairs on the mechanism. Select a appropriate scale to draw the kinematic diagram on the report with you pencil, ruler, compasses and other tools. Starting from the driving link, mark each link with number (1, 2 ---) and each kinematic pair with (A, B ---) in sequence. Label an arrow on the driving link indicating the direction of motion.

5. The Example

Draw the kinematic diagram of the mechanism bellow and calculate the degrees of freedom.

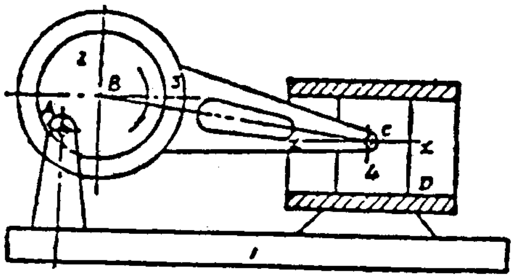


Figure 1-1

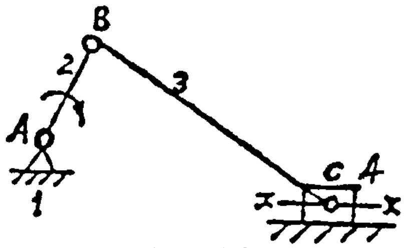


Figure 1-2

1. Select the eccentric wheel as the driving link and rotate slowly. Distinguish the mechanism is composed by which components according to the relative movement between the links. In Figure 1-1, the mechanism is composed by 1 - rack, 2 - crank, 3 -link, 4 - slider.

2. Observe the relative movement characteristics between links carefully from the driving link according to the mechanism motion transfer sequence. Determine the type and number of kinematic pairs. In Figure 1-1, crank 2 is driving link, the motion

transmission sequence is: crank 2, link 3, slider 4. The rotational center of the rotary link is the geometric center of the rotary surface. Component 2 is an eccentric wheel, and a revolute pair forms with link 1 at point A. Link 3 and link 2 compose a revolute pair at point B. Link 4 and Link 3 compose a revolute pair at point C. Link 4 make relative linear motion along the X-X direction on link 1 composing sliding pair.

3. Select a location for the crank to correctly express the motion of the mechanism simply and clearly. Draw the kinematic sketch diagram on a scratch paper starting from the moving links in accordance with the order of each link connection， using the allowed symbols and simple lines.

4. Calculate the degree of freedom of the mechanism.

(1)The calculation formula for degree of freedom: $F=3n-2P_L-P_H$

For this example, n=3, P_L =4, P_H =0, substitute them into the above formula.

$$F=3n-2P_L-P_H=3\times3-2\times4-0=1$$

(2) Check calculation results

Observe the movement of each link. It can be shown that the movement of the mechanism is determined. The degree of freedom should be greater than zero and equal to the number of driving links. Through calculation, it can be found that F = the number of driving links. That can be used to verify the correctness of the kinematic sketch diagram.

5. Measure the distances L_{AB}, L_{BC} between the centers of two revolute pairs on the links 2, 3. Measure the distance between revolute pair A to the motion track X-X of the slider. According to the kinematic

sketch diagram, draw kinematic diagram with a certain scale on the report as Figure 1-2 shown.

6. Experiment Report

Choose one mechanism model and draw its kinematic diagram with the simplest lines sequentially connecting kinematic pairs. Starting from the driving link, mark each link with number (1, 2 ---) and each kinematic pair with (A, B ---) in sequence. Label an arrow on the driving link indicating the direction of motion.

Draw kinematic diagram here:

Scale： μ =_____________

The number of moving links： n =____________

The number of lower pairs： P_L =_____________

The number of higher pairs： P_H =_____________

Redundant constraints： P’ =_____________

Passive degrees of freedom： F’ =_____________

Degrees of freedom： F=_____________

Experiment 2 Measurement and Analysis of Mechanical Kinematic parameters

1. Experimental objectives

1. Through experiment, understand the measuring method of the displacement, velocity and acceleration and the measuring method of velocity and the irregular rotation unevenness rate.
2. Through experiment, preliminary understand the basic principles of QTD-Ⅲ Type combined mechanism bench and optical pulse encoder, the sync pulse generator (also called angle sensor) and master skills to use them.
3. By comparing the theoretical motion graphs and measured motion graphs, identify differences and analyze the causes.

2. Experimental Equipments and Principles

Experimental System is shown in Figure 2-1

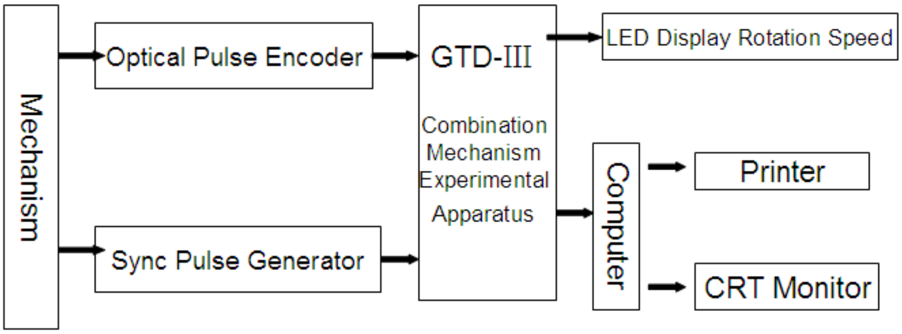
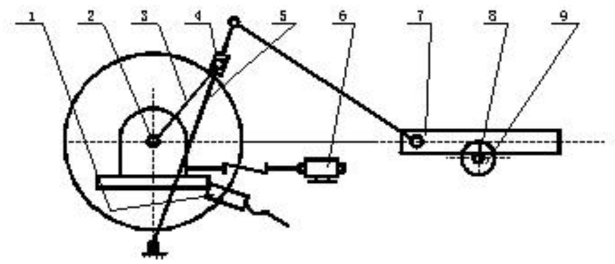


Figure 2-1 Mechanical movement parameters determination experimental system operation principle graph

1. Experimental mechanism: crank and swing guide-bar mechanism.

Shown in Figure 2-2, its driving force is DC motor. The motor velocity can be adjusted within 0-3000r/min for stepless velocity regulation. Decelerating by worm type of reduction gearing reducer, mechanism crank velocity is 0-100r/min. Using reciprocating slider to push optical pulse encoder, output a pulse signal corresponding to the slider displacement. Processed by tester, we can get slider's displacement, velocity and acceleration.

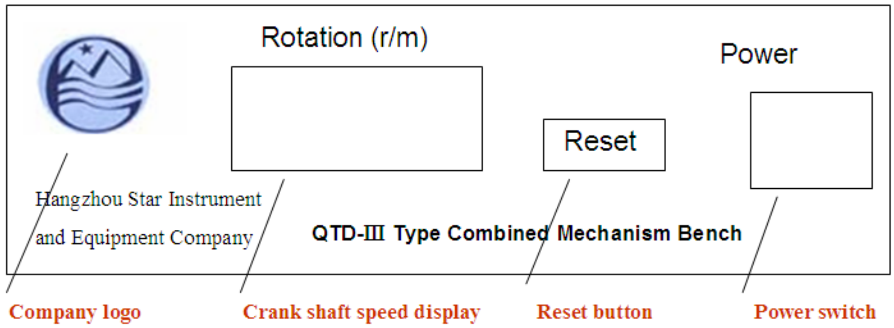


Crank-pilot bar mechanism

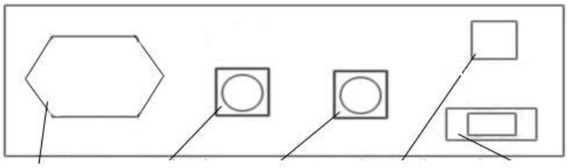
Figure 2-2 Experimental mechanism sketch

1. sync pulse regenerator; 2. worm type of reduction gearing; 3. crank; 4. slider; 5. guide bar; 6.motor;7.slider; 8.gear;9. Optical pulse encoder 10.eccentric wheel; 11. cam; 12.grating disc; 13.flash push rod; 14.return spring.

2. QTD-Ⅲ type combined mechanism bench：The experimental instrument shape structure shown in Figure 2-3.



(a) QTD-Ⅲ experimental device front structure



(b) QTD-Ⅲexperimental device back structure

Figure 2-3 QTD-Ⅲ Type Combined Mechanism Bench

The experimental mechanism is made up of smallest single-chip system. There is 16-bit expanding counter connected with three LED digital tube display the crank shaft speed when mechanism moves, meanwhile, it can make serial communication with the PC asynchronous. In the experiment of mechanical dynamic movement process, slider's reciprocating movement output a frequency by photoelectric pulse encoder conversion (frequency and speed is proportional to the reciprocating slider), two pulses of 0-5 volts level are connected to the microprocessor expansion counter for counting.

Preliminary processing operation by microprocessor and sent to PC for processing. PC can display the corresponding data and motion curve graph in CRT by software system.

Mechanism also has two way signals sent to the microcomputer minimum system. They are pulse signals sent by angle sensor. One of them is the encoder angel pulse for sampling angle and obtain motion curve. The other one is index pulse which used to calibrate zero position while sampling data. Mechanism velocity and acceleration values are obtained by displacement numerical differentiation and digital filtering.

3. Photoelectric pulse encoder: it is also called incremental photoelectric encoder. The encoder is a device using circular grating by photoelectric conversion which convert shaft angular displacement into electrical pulse signal. It is made up of luminophor, condensing lens, photoelectric coded disk, diaphragm, photosensitive tube and photoelectric shaping amplification circuit.

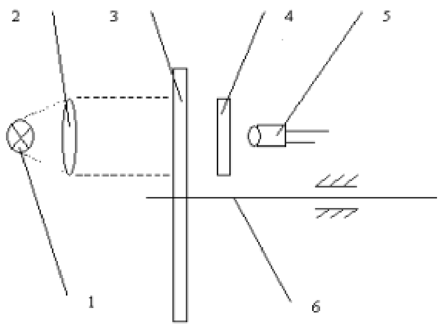


Figure 2-4 photoelectric pulse encoder

1. bulb; 2. condenser; 3. photoelectric coded disk; 4. diaphragm ; 5. photosensitive tube; 6. spindle;

3. Experimental Procedures and Requirements

Switch sequence:

Open: QTD-III type combined mechanism bench mechanism →computer → experimental mechanism

Close: experimental mechanism → computer → QTD-III type combined mechanism bench mechanism

Measurement of slider displacement, velocity, acceleration

(1) Turn on the power of QTD- III combined mechanism bench, while the panel with LED digital tube display “0”.

(2) Turn on computer.

(3) Before the mechanism power on, student should counterclockwise rotate the motor speed control potentiometer to the lowest speed position, and then connect the power, start mechanism. Turn speed potentiometer clockwise to make speed increased to the desired value gradually (otherwise it's easy to burn out the fuse, even damage the governor). The display panel is displayed in real time on the crank shaft speed.

(4) After mechanism functions normally, operation can be carried out on the computer. Start system software.

(5) Choose a serial port, and set the corresponding selection of sampling method and sampling constant in the pop-up sampling parameter region. We can choose timing sampling mode and time constant of sampling has 10 selected gear (respectively 2ms, 5ms, 10ms, 15ms, 20ms, 25ms, 30ms, 35ms, 40ms, 50ms), such as 25ms. We can also choose a fixed angle sampling mode, angle constant of sampling has 5 selected gear (respectively 2 degrees, 4 degrees, 6 degrees, 8 degrees, 10 degrees), such as choose 4 degrees.

(6)Press the "sampling" button, start sampling. (Please wait several minutes, the tester is sampling on the mechanism motion while received PC instruction and return data to PC machine, PC machine would obtain motion displacement value by certain processing of received data).

(7) When the sampling is completed, "motion curve drawing zone" will show in the interface. Rendering the displacement curve and

on the left side of the "data display area" display the sampling data.

(8) Press “data analysis button”. “Motion curve drawing zone" will gradually draw the corresponding curves of velocity and acceleration curve in the displacement curve. At the same time on the left side of the “data display area” will also increase the velocity and acceleration value of each sampling point.

(9)Record experimental data in the experiment report.

4. Experiment Report

Mechanism: crank and swing guide-bar mechanism

Displacement, velocity and acceleration test

	displacement（mm）	velocity（m/s）	acceleration（m/s^2）
slider displacement, velocity, and acceleration test	S_{max}=	v_{mas}=	a_{max}=
	S_{min}=	v_{min}=	a_{min}=

Experiment 3 Mechanism Combination and Design

1. Summary

Planar linkage mechanism is the main mechanism of many kinds of machinery such as: loader, press, dump truck, medical bed etc. The selection of the planar linkage mechanism is the first step to a success mechanical design. There is no simple method based on reliable rule in mechanism type selection. Designers often make it through drawing and calculation combined experience, parameter without intuitive physical verification. The design would be inconsistent with the actual requirements or unable to realize.

In order to enhance the effectiveness and intuitive of experiment, we would use multi-functional portfolios and experimental design mechanism. Students have a large number of versatile accessories for the experiment to use and assemble arbitrarily. The accessories can form a variety of planar linkage (including multi-pole and high- deputy) mechanism types and is able to adjust mechanism stepless in all sizes and depict any point on the trajectory curve rod. Student will assemble physical model in the experiment according to their various institutions conceived and simulate the real situation, make intuitive design layout adjustments and improved design scheme.

2. Experimental objectives

1. Further deepen the understanding of the mechanism knowledge

and comprehensive application ability.

2. Cultivate innovation consciousness and synthesis design capabilities.

3. Experimental Tools

Students prepare a pencil, a ruler, an eraser and compasses.

4. Experimental Procedures and Requirements

According to the design before experiment, select appropriate links design a combined mechanism on the experiment platform requiring the degree of freedom of the mechanism is 1.

Draw the kinematic diagram of the mechanism and calculate the degree of freedom.

5. Experiment Report

Draw kinematic diagram of the mechanism designed with the simplest lines sequentially connecting kinematic pairs. Starting from the driving link, mark each link with number (1, 2 ---) and each kinematic pair with (A, B ---) in sequence. Label an arrow on the driving link indicating the direction of motion.

Draw kinematic diagram here:

Scale：μ =____________

The number of moving links：n =____________

The number of lower pairs：P_L =____________

The number of higher pairs：P_H =____________

Redundant constraints：P’ =____________

Passive degrees of freedom：F’ =____________

Degrees of freedom：F=____________