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The Experimental Research of the Control System of Flexible Hose Instability

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Abstract: The experimental control system of the superelastic hose instability is based on S7-200PLC as controller. The superelastic hoses are sealed at their both ends. The breakdown condition of that is taken as the object of study under different combined and working conditions. The upper computer of the experimental bench adopts MCGS configuration software. The test of experiment can meet the control and real-time monitoring of experimental platform conditions. In the experiment, we measure and monitor the data of temperature, tensile force, pressure and so on by the analog modules. During the process of experiment, the actuators like the solenoid valve and the motor are controlled by the switch. The paper describes that the constitution of experimental control system of the superelastic hose instability, control function and the achievement of monitoring condition. It is convenient to operate in the control system, the design cost is low, the man-machine interface is simple and understandable, and the experimental control system will be significant in bio-engineering and medical research.

Keywords: PLC; MCGS; superelastic hose; experimental control system

1 Introduction

The local and unstable phenomenon of superelastic hoses is similar to the growth mechanism of arterial aneurysms in bio-engineering, so it is great significant to treat arterial aneurysms. The previous research used the control system which is a relative and single research of weight axial tension; there are many research of experimental platform such as PLC, king-view, WINCC and other designs of combinations. The experimental control system considers S7-200 PLC as the controller, uses MCGS configuration software in order to design man-machine picture and continues to control and real-time monitor for the experiment.

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2 The composition of experimental control system

The unstable control system of the superelastic hose which boasts the overall structure is shown in Figure1. The core of the control selects PLC200 in the experiment and the superelastic hoses in the experimental tank are the experimental objects. The data of temperature, tension and pressure in the experiment are collected by the sensors. Then the data are transmitted to the analog module in order to deal with it. Finally the processing data is uploaded to the host computer to realize the real-time monitoring and control of the data. During the experiment, the actuators such as the solenoid valve and the motor are controlled by the switch. The RS-485 serial communication connects the computer and PLC. The programming software of STEP7-Micro Win and MCGS configuration software carry out the mixed programming for the experiment, and the experiment carry out process monitoring and condition monitoring.

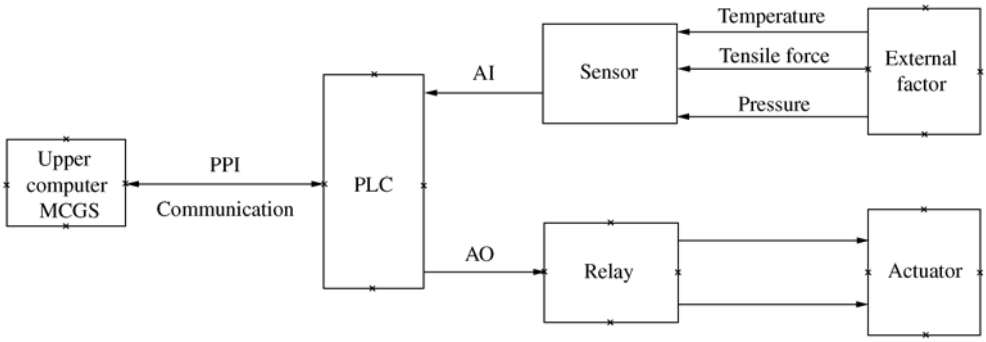

Figure 1 The structure of unstable experimental control system of superelastic hose

2.1 Control object

The superelastic hoses are the ultimate research object and its destabilization process simulates the formation process of arterial aneurysm in bio-engineering. Experiments achieve unstable phenomenon of elastic hose under different conditions by changing the analog temperature, tension, pressure and switch under the control of the solenoid valve and the various motors.

2.2 Analog collection

Temperature measurement uses PT100 Pt RTD and its measurement range is 0 ~ 50 ℃; tension measurement uses tension sensor and its measurement range is 0 ~ 10 kg; pressure measurement uses pressure transmitter and its measurement range is 0 ~ 5 MP. After data collection, data will be transported to the analog module of the PLC.

2.3 The controller

The controller selects CPU as the PLC of 224XP and the host has 14 input points and 9 output points. The communication interface is a 9-pin RS-485 signal interface and is connected to the host computer by a PC/PPI cable. The expansion interface of the S7-200 series is main line form, which can be connected to a I/O unit of switch quantity or an analog I/O unit. The system expands the output module of EM222 digital quantity, input module of EM231 analog, EM223 digital input and output module. The PLC composite structure is shown in Figure 2.

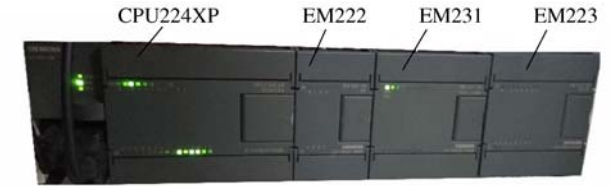

Figure 2 PLC composite structure

3 The design of system application software

The control system application software of superelastic hose instability is completed by MCGS configuration software and Figure 3 shows its main structural form. The process of experiment includes various working modules and every working module can reflect the unstable condition of elastic hose under the different conditions and can gain various data to continue the experimental analysis, which has overall research for arterial aneurysm in the bio-engineering.

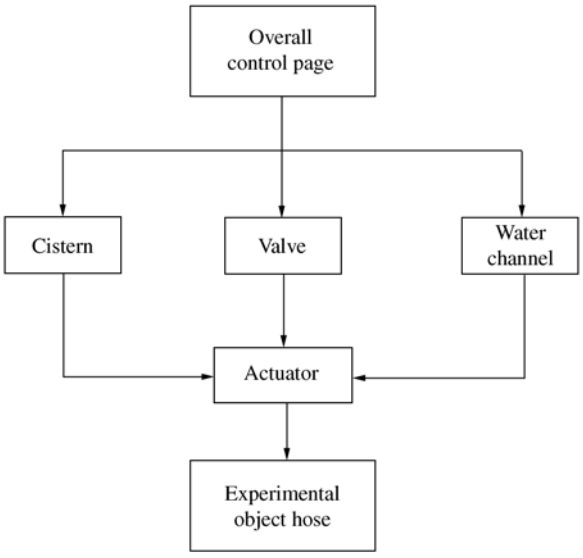

Figure 3 The structure of control system application software

3.1 The control of multi-working interface

1) The Figure 4 shows the control interface of cistern. The cistern drives up-down of lead screw by DC step motor and achieves different pressure by adjusting the height of cistern. The DC step motor continues to edit program in order to adjust its revolving speed by STEP7-Micro Win programming software.

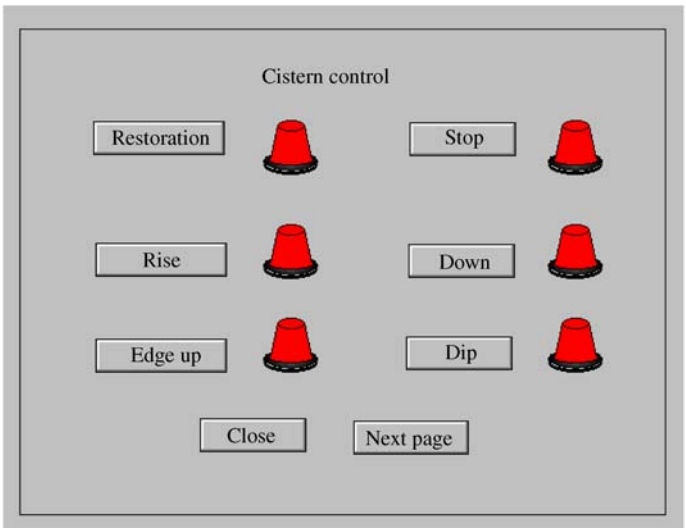

Figure 4 Control interface of cistern

2) Figure 5 shows the multi-loop control. This interface can achieve various working routes, complete various experiments and collect different data; the other interfaces can achieve the motion from cistern, water tank, air pump and water pump in order to provide power for experiments.

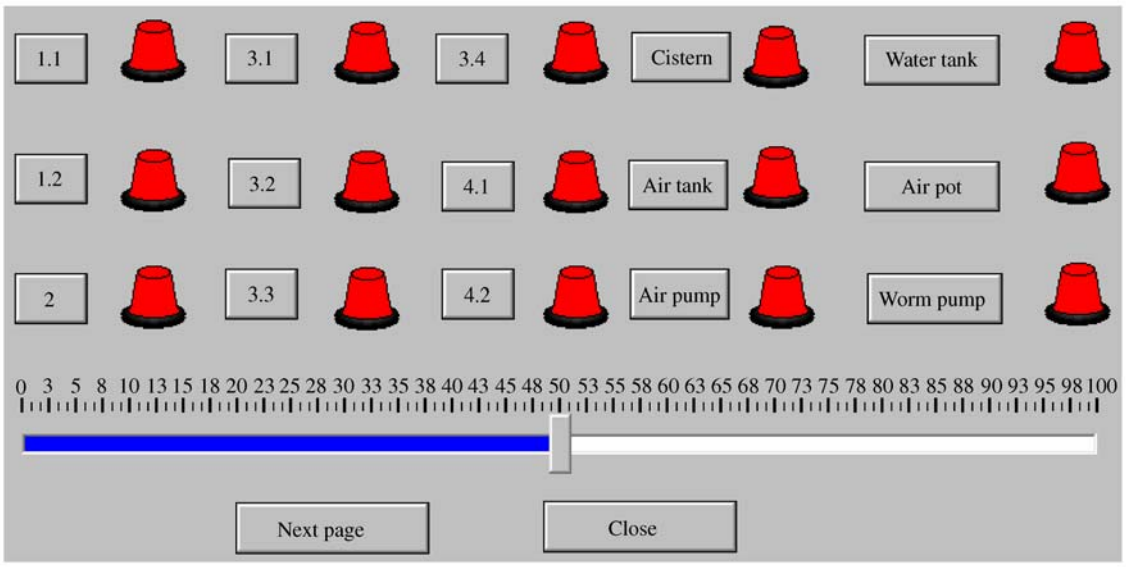

Figure 5 Show of multi-loop control

3) The Figure 6 shows the control interface of water channel. The control interface can achieve the motion of various electrical machines: the sink motor is a major power to achieve the superelastic hose instability; bracket motor and camera motor are considered as power to complete high-speed record in the field of multi-dimension and multiaspect. The control interface includes the setting of the sliding block of water channel's speed, distance and tensile parameters. The curve diagram of tension in the interface can display the real-time tension condition of elastic hose in water channel. The setting of parameters are transformed into the PLC to be calculated.

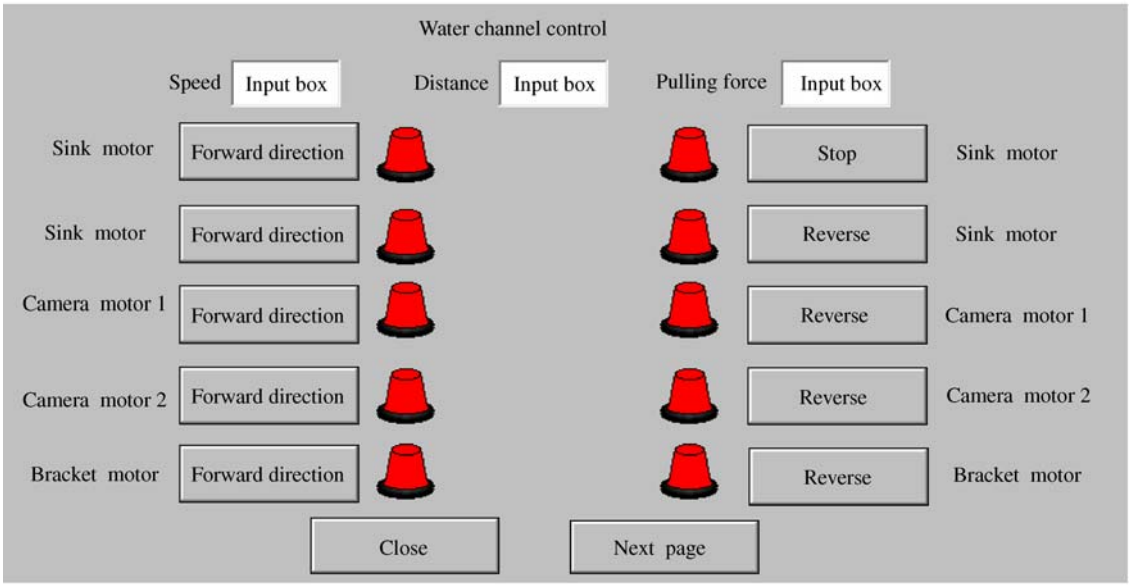

Figure 6 Control interface of water channel

3.2 The achievement of monitoring function

MCGS configuration software monitors the condition of experiment. For example, the Figure 7 shows the whole working simulation diagram of control system of superelastic hose instability. We can set the controlled variable and report as well as curve diagram, monitor the data in real time by human-computer monitoring interface.

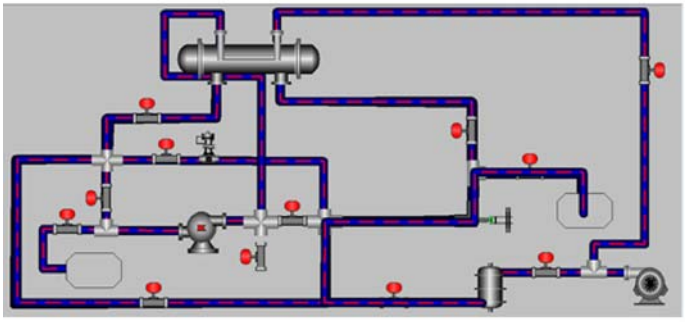

Figure 7 The system total workflow

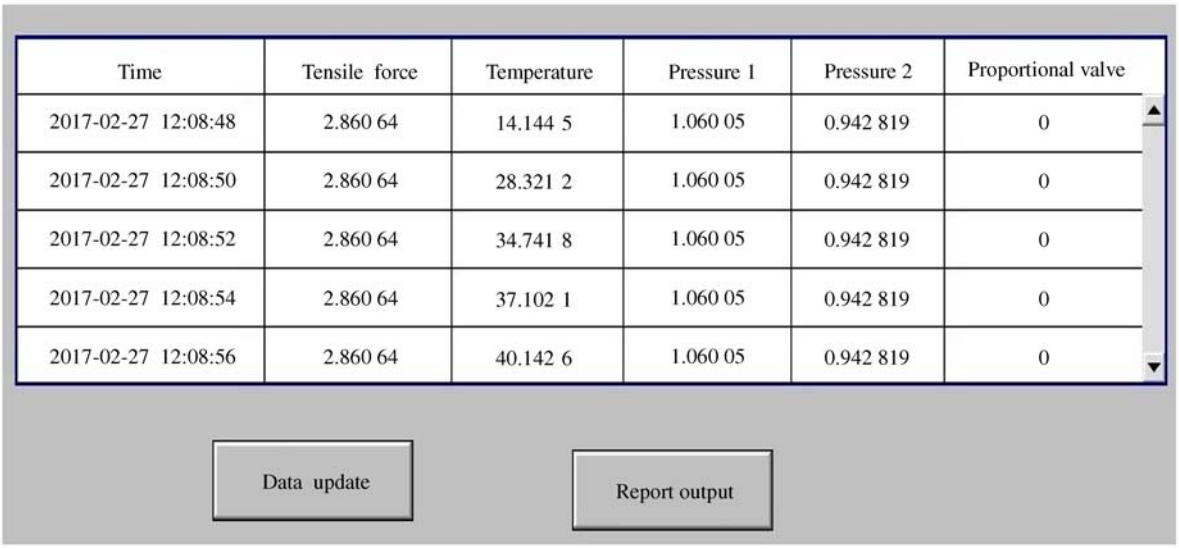

Figure 8 Experimental montoring curve diagram

4 Conclusions

The structure of control system of superelastic hose instability is simple, flexible and cost-effective. Experimental control device vividly simulates the process of arterial aneurysm formation in bio-engineering, it can combine computer and PLC control technology as well as monitor and control the analog temperature, tension, pressure and the switch quantity. What's more, it can well research drum shape, the critical pressure value, pressure and so on under the unstable and inflatable elastic hoses. It is of great social benefits to research biological engineering and medicine.

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