Research and manufacture of practical training device for urban rail transit vehicle control system

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Abstract: Through research to understand the teaching status of domestic railway colleges: for example, some colleges of "cognitive urban rail transit vehicle driving" teaching is carried out in the train cab, because the train cab space is small, can only accommodate 4-5 people, and the executive mechanism in other parts of the vehicle, the teaching effect is affected to a certain extent. Therefore, the development of open structure, function close to the real urban rail equipment, will be well received by the relevant professional vocational colleges demand and welcome.

Key words: urban rail; Train driving

1. Technical requirements of the project

1.1 The main contents of the project development

This project is mainly composed of driver console, electrical control system and actuator system. The driver control console installation panel, the driving display control unit and the carrier of human-machine interface. The electrical control system is mainly composed of operation indicating unit, circuit breaker group, Siemens S7-200PLC, relay group, signal acquisition unit, battery group, DC110V switching power supply, DC24V switching power supply, DC5V switching power supply, wiring bar, mesh rack, wiring slot, left cable and right cable. The actuator system is mainly composed of pantograph, passenger information control unit, traction and braking mechanism, inverter control unit, brake resistance, air circuit, air conditioning motor, monitoring unit and so on.

1.2 Main technical route

(1) The traction process is jointly determined by the driver display unit, the driver control handle, the mode selection knob and the driver alert button. PLC detects and processes the status of DCH, MS and DMC, and outputs the corresponding control information to the three-phase inverter. The three-phase inverter controls the speed and direction of the traction motor according to the control requirements of the PLC, and the motor drives the hub to rotate to simulate the train operation. Figure 1 shows the traction block diagram. The three-phase full bridge is controlled by DSP.

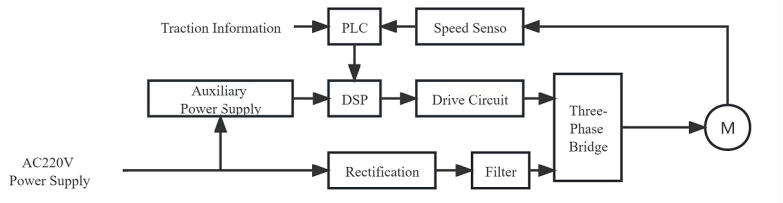

Figure 1 Block diagram of traction process

(2) The passenger information control unit consists of the station information control board and the voice station announcement control board. Station information control board is used to control LED passenger room dynamic map, passenger room display; The voice station announcement control board is used to control the guest room voice announcement device. The core unit of the station information control board and voice announcement control board is DSP controller, which communicates with DDU through RS485 bus. Station information control board through communication with PLC, control 2 LED passenger room dynamic map, each line has 16 stations. Passenger room display operation and passenger room arrival information, passenger room display is composed of 5 16×16 LED light emitting diode array.

Station information, language station information, signal acquisition information and PLC communication methods are shown in Figure 2. The site information control board card is used as a slave in the RS485 communication network, the default address is 1, the communication baud rate is 9600bps, and PLC is used as the master station; The language station control board card is used as a slave in RS485 communication network, the default address is 1, the communication baud rate is 9600bps, and PLC is used as the master station; The signal acquisition board card is used as a slave in the RS485 communication network, the default address is 1, the communication baud rate is 9600bps, and PLC is used as the master station.

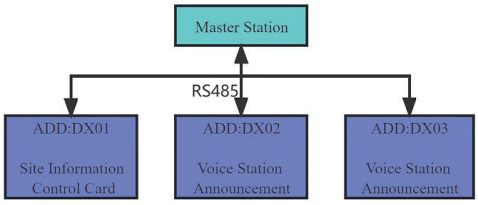

Figure 2 communication mode

2. Characteristics of the project

2.1 Open training platform.

2.2 Reflect the real process of urban rail transit vehicle training operation, static and dynamic testing.

2.3 179 fault monitoring points have been arranged, and through troubleshooting, the composition and working principle of the urban rail vehicle control system can be deeply understood.

3. The system composition and function

3.1 Composition of the driver control platform

The driver control bench is a carrier installed with N1 panel, N2 panel, N3 panel, N4 panel, N5 panel, N6 panel, driving display control unit DDU and human-machine interface HMI for the driver's observation and operation.

3.2 Composition of electrical control system

1. Basic composition. The electrical control system is mainly composed of operation indicating unit, circuit breaker group, Siemens S7-200PLC, relay group, DSP control unit, battery group, DC110V switching power supply, DC24V switching power supply, wiring bar, mesh rack, wiring slot, left cable and right cable.

2. DSP signal acquisition unit. The signal acquisition board is used to collect battery voltage, brake pressure and speed. The collection voltage range of the battery is: DC0-140V, the analog voltage range corresponding to the collection brake pressure is: DC0-5V, and the collection signal of the speed is pulse signal.

3.3 The composition of the actuator system

1. Basic composition. The actuator system is mainly composed of pantograph, passenger information control unit, traction and braking mechanism, inverter control unit, brake resistance, air circuit, air conditioning motor, monitoring unit and so on.

2. Pantograph

Basic structure

The pantograph is mainly composed of a collector head, an upper support rod, an upper support rod lifting mechanism, a lower support rod lifting mechanism, an upper and lower support rod lifting limit switch, a lower support rod and a bottom frame.

Pantograph lifting control

(1) When the pantograph control switch SB6 on the driver's control platform is in the network position, click the pantograph rise icon control in the DDU train preparation interface to raise the pantograph; Click the pantograph drop icon control in the DDU train preparation interface to lower the pantograph.

(2) The pantograph control switch SB6 on the driver's console also has the emergency traction position and pantograph drop position. When SB6 is in the emergency traction position, the pantograph rises; When SB6 is in the pantograph drop position, the pantograph descends.

3. Passenger information control unit. The passenger information control unit consists of the station information control board and the voice station announcement control board. Station information control board is used to control LED passenger room dynamic map, passenger room display; The voice station announcement control board is used to control the guest room voice announcement device. The station information control board and voice announcement control board communicate with DDU through RS485 bus.

4. Station information control board. Station information control board through communication with PLC, control 2 LED room dynamic map, room display operation and room arrival information.

The dynamic map of the passenger room is composed of 2 subway lines, each line has 16 stations.

The passenger room display consists of five arrays of 16×16 LED light emitting diodes. The operation of the dynamic map of the passenger room, the display screen of the passenger room and the station announcer of the passenger room are carried out in the passenger room information interface of the DDU.

5. Voice station announcement control board. Voice announcement control board through communication with PLC, control 2 real-time station information broadcast. Figure 4-7 shows the PCB diagram of the terminal of the voice announcement control board.

3.4 Traction and braking mechanism

1. Basic structure. As shown in the figure is the traction brake system, which is mainly composed of inverter, traction motor, brake resistance, friction brake component and motor speed sensor.

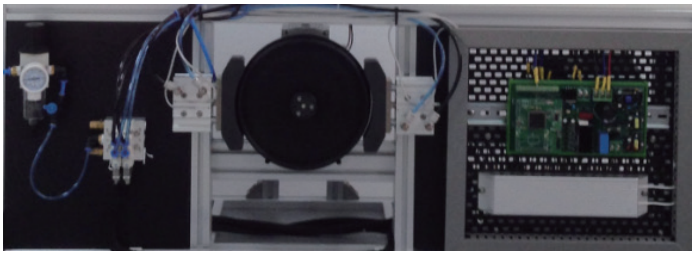

FIG. 3 Traction and braking mechanism

(1) Inverter. The inverter receives the control information of the PLC to realize the speed control and positive and negative control of the motor, which is used to simulate the traction mode of the train.

The inverter adopts TI company TMS320F2812 DSP as the core processor. DSP detects the control instruction issued by PLC, and generates the corresponding PWM pulse by setting its internal PWM module register. The pulse signal passes through the drive circuit for current amplification, which is used to drive the motor. In order to prevent the power circuit from causing interference and damage to the control circuit, the control circuit and the power circuit are isolated by the way of optocoupling isolation on the circuit. The switching device adopts FSBB20CH60 intelligent power module. The intelligent power module is integrated with 6 IGBTs and the necessary protection circuit and drive circuit.

(2) Brake assembly. Brake assembly includes electric brake and friction brake two types of components, the electric brake part is mainly composed of brake resistance, friction brake part is composed of two brake shoes respectively installed on two thin cylinder with guide rod, located on both sides of the wheel. PLC controls the two cylinders, friction braking, the cylinder to push the brake shoe to reduce the wheel speed, to achieve friction braking.

3.5 The working process of traction and braking

1. Traction process. Traction information is specifically displayed by the driver's display unit DDU, and the traction instruction is transmitted to the PLC unit after the driver's control handle DCH, mode selection knob MS and driver's alert button DMC logical calculation. PLC then detects and processes the status of DCH, MS and DMC, and outputs the control information to the three-phase inverter. Three-phase inverter according to the PLC control requirements, control the direction and speed of traction motor, motor output end with hub, through the hub rotation simulation train operation.

2. Braking process. When the train is braking, the braking mode is selected according to the train speed value. When the speed value is high, the resistance braking is preferred. When the speed value is reduced to low speed, the resistance braking is released and friction braking is applied until the train speed is zero. In case of emergency, the train needs emergency braking, then apply friction braking and resistance braking at the same time.

3. Brake the air path

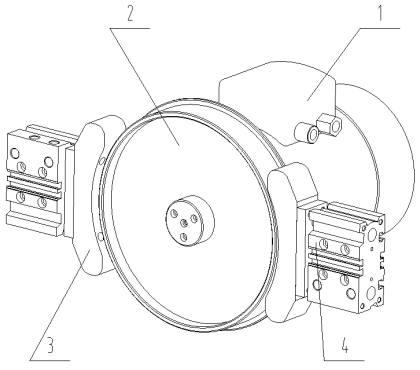

Figure 4 Friction brake assembly

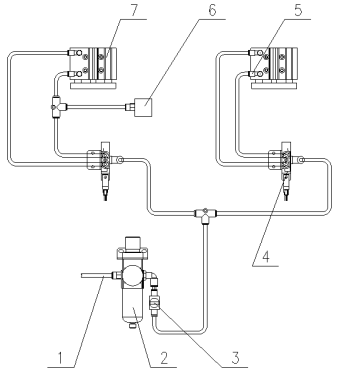

Figure 5 Brake air path

Brake air path

1- intake hose; 2- filter pressure reducing valve; 3- manual valve; 4- solenoid valve; 5- quick change joints; 6- barometer; 7- thin type cylinder with guide rod

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