

Design of PLC Control System for Intelligent Coal Transport Vehicle

Huadong Zang¹, Yadong Chen²

¹Suzhou Vocational Institute of Industrial Technology, Suzhou 215104, China.

²Liaoning Tiefa Energy Co., Ltd, Tieling 112700, China.

Abstract

With the rapid development of economy, automation and intelligent technology is becoming more and more mature, the intelligent level of manufacturing industry is improved, and the establishment of intelligent factory with better adaptability and higher resource efficiency is the direction of enterprise development. Intelligent coal transport vehicle is one of the core of modern coal technology development. In this paper, a general intelligent coal transport vehicle system is proposed, which can collect the required information and control the operation of coal transport vehicle planning path by connecting relevant sensors through programmable controller. The system uses new energy battery power supply, which has the characteristics of green, safe, convenient and reliable.

Keywords

Intelligent transport vehicle, PLC, Control program.

1. Introduction

With the rapid development of the national economy, the automation and intelligent production of enterprises are becoming more and more mature. In today's increasingly high human cost, how to reduce the human resource cost of enterprises, improve the intelligent level of manufacturing industry, and establish a smart factory with better adaptability and higher resource efficiency is the theme of enterprise development. All coal enterprises need mature and reliable intelligent coal transport vehicles. This paper presents a general intelligent coal transport vehicle system. The control system of intelligent coal transport vehicle is based on programmable logic controller (PLC), which is connected with general analog input module through programmable controller to complete the acquisition of required sensor signals and control the coal transport vehicle to complete the planned operation. The system uses new energy battery as power, which has the characteristics of green, safe, reliable and convenient.

2. Control System Scheme of Intelligent Coal Transport Vehicle

The control system block diagram of intelligent coal transport vehicle is shown in Figure 1. It mainly includes the main controller (PLC), various sensors (hydraulic sensor, tilt sensor, collision sensor, etc.), control objects (walking motor, steering motor, brake hydraulic pump, brake solenoid valve) and touch screen. The 4ad2da module realizes the acquisition and conversion of analog input signal and the output of analog quantity controlled by walking motor speed. The steering position encoder is used to feed back the current steering angle data, and its data and battery status data are exchanged with PLC through RS-485 communication mode. COBOX communicates with the upper computer control system (automatic driving system).

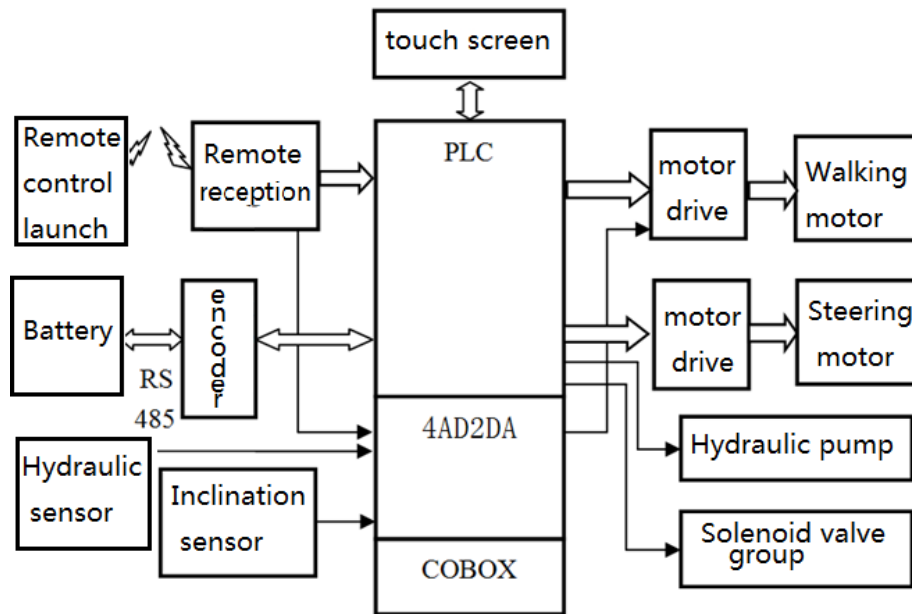


Figure 1. System block diagram

3. Software System Design of Intelligent Coal Transport Vehicle

3.1. Modular Design of Control Program

The control system program of coal transport vehicle can be divided into: free communication program, analog initialization processing and calculation program, travel program, steering program, brake program, alarm program, etc. Modular design is to design and develop the control program through the method of compiling and realizing the functions separately, that is, to write a single function program first, and then to debug and realize, to complete the programming of all functions gradually, and then to string all the control functions together.

3.2. PLC control Program

3.2.1 Free communication program

The free communication program realizes PLC to read the angle signal of photoelectric rotary encoder and read the battery status information. Fig. 3 shows the ladder diagram of the program for reading the data of the photoelectric rotary encoder. That is, S0 is the state of reading angle degree. D300 ~ d307 stores the sent instruction data 01 03 00 00 01 840a. Send sends the data instruction for the serial port. RCV D310 K14 K2 is the serial port data receiving instruction, and the received data is placed in 14 registers at the beginning of D310. The SHL and add instructions are used to convert the received data into the angle data of the encoder and store them in the d102 register. Fig. 4 shows the ladder diagram of reading battery status data.

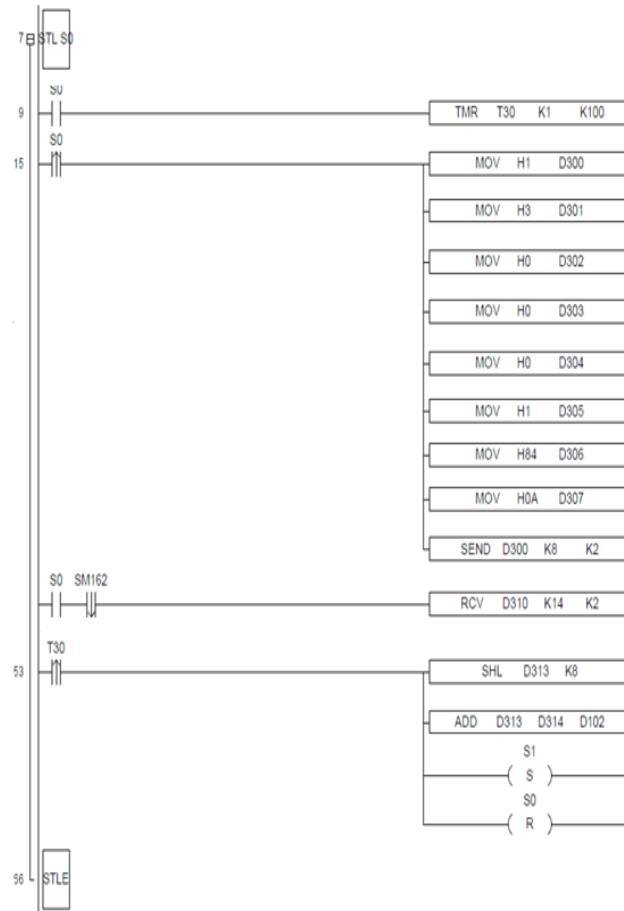


Figure 3. Read encoder data ladder diagram

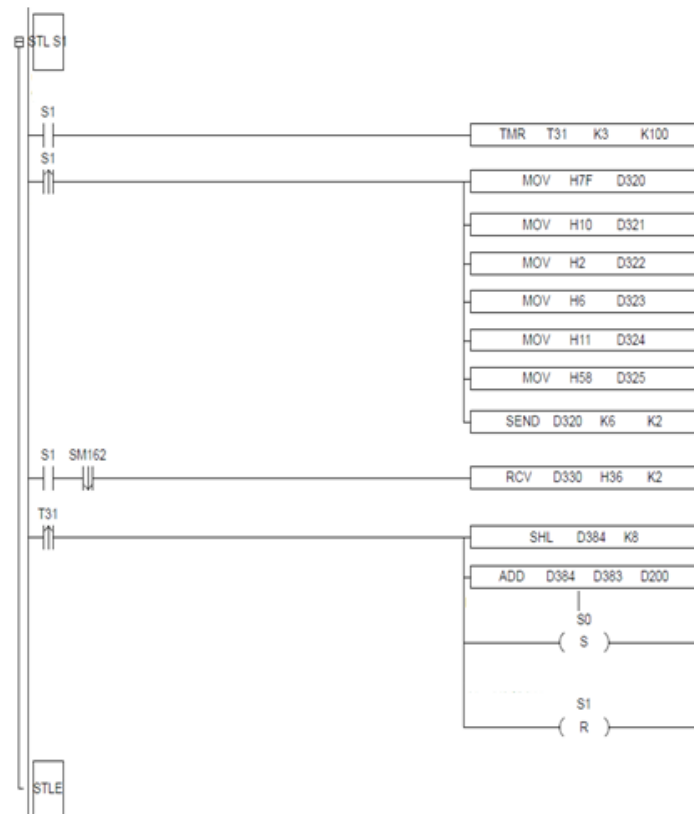


Figure 4. Read battery status data ladder diagram

3.2.2 Analog initialization processing and calculation program

The PLC ladder diagram of analog initialization processing and calculation program is shown in Fig. 5. Realize the numerical conversion of analog data, input and output enable work. Analog module ad input channel 1 is connected with the brake oil circuit oil pressure transmitter, and the oil pressure value (0 ~ 16383) is stored in register D2, and then converted into pressure value (kg / cm²) through calculation. Floating point number is stored in D4 and integer number is stored in D6. Analog module ad input channel 2 is connected with inclination angle transmitter signal, and the corresponding data is stored in d34. The remote control speed value is input through ad channel 3 and stored in the latch register HD0 after processing. Analog output channel 1 is the output channel of speed control voltage, which outputs 0 ~ 5V analog voltage. Y10000 ~ y10002 are the enabling control signals of analog input AD1 ~ AD3.

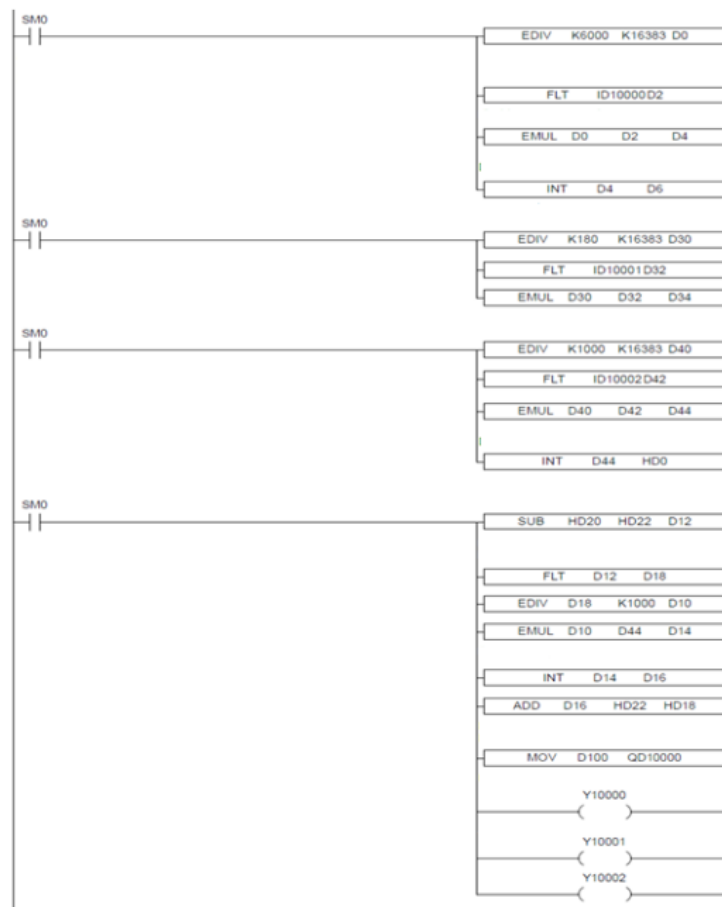


Figure 5. Analog initialization processing and calculation program

3.2.3 Marching procedure

The moving process of intelligent coal transport vehicle includes two parts: forward and backward. Y10004 is the speed control analog output enable signal. Y2 controls the motor operation, Y3 controls the motor direction, Y3 has a signal for forward, no signal output for reverse (backward). Figure 6 shows the forward execution procedure. Figure 7 is the control program of the intelligent coal car backward action.

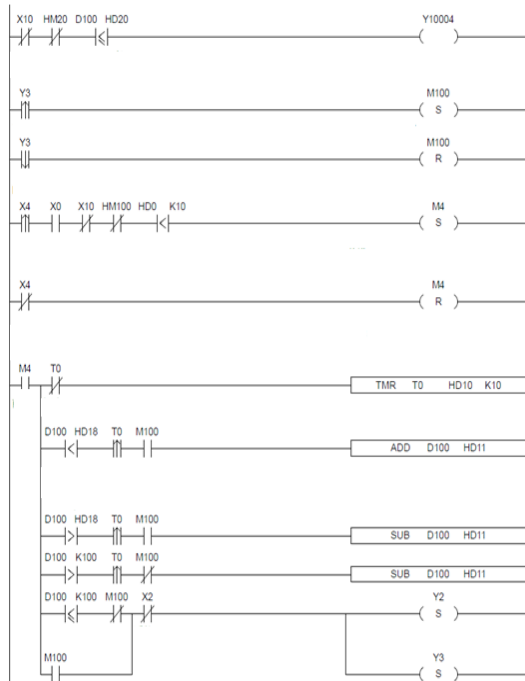


Figure 6. Forward control program

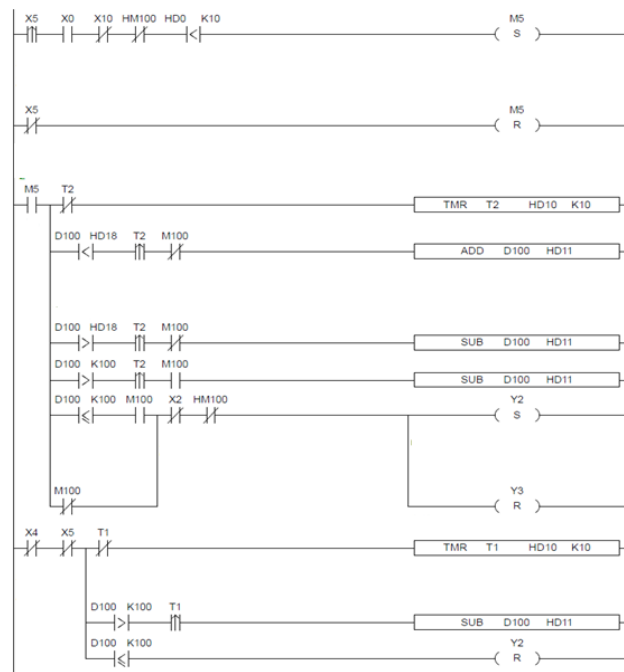


Figure 7. Backward control program

4. Software Debugging of Intelligent Coal Transport Vehicle

When the hardware debugging and testing of the intelligent coal transport vehicle are completed, the software debugging is carried out. In the open ground, the intelligent coal transport vehicle can be operated by remote control to control the forward, backward, left turn, right turn and speed control. Check whether the working procedures meet the control requirements, and modify the procedures according to the phenomena until the control requirements are normal.

5. Summary

The intelligent coal transport vehicle system has passed the relevant technical tests, and the technical indicators have reached the design requirements. Under the condition of loading 2 tons, it can complete the work links of forward, acceleration, left turn, right turn, deceleration, brake and brake, and the working process is smooth. When encountering obstacles, it can stop and brake in time and give an alarm.

The man-machine interface system can communicate with PLC normally, realize the real-time display of intelligent coal car status information, and modify and set the relevant setting parameters, so as to achieve the human-computer interaction function required by the design. The research work has achieved certain results. The intelligent coal transport vehicle can be applied to intelligent storage system and automatic driving system. In combination with the automatic driving system, the following aspects need to be further studied.

Through the CANOPEN protocol, a reliable control information link is established with the upper computer of the automatic driving system. This requires the addition of CANopen protocol communication service program on the basis of this system. At the same time, the authority management level is set, and the automatic driving upper computer generally has the highest control authority.

In this paper, the safe operation of coal transport vehicles only set up the parking brake link of collision. In terms of safety control, we can further study the increase of non-contact obstacle avoidance links such as laser radar to improve the safety level.

References

- [1] Gong Shujuan, Yang Shizhao. Electrical control design of material carrier based on PLC [J]. Light industry technology, 2019,35 (11): 67-68.
- [2] Zhao Fenqiang. Design of coal mine feeding trolley system based on PLC control [J]. Western exploration engineering, 2019,31 (02): 121-122 + 125.