

Design of PLC Control System for Intelligent Coal Transport Vehicle

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Abstract

With the rapid development of economy, automation and intelligent technology are becoming more and more mature, the intelligent level of manufacturing industry is improved, and the establishment of a smart factory with better adaptability and higher resource efficiency is the development direction of today's enterprises. Intelligent coal transport vehicle is one of the cores of the development of modern coal technology. This paper presents a general intelligent coal transport vehicle system, which connects relevant sensors through programmable controller to complete the collection of required information and control the operation of coal transport vehicle planning path. 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 national economy, the automation and intelligent production of enterprises are becoming more and more mature and perfect. All coal enterprises need mature and reliable intelligent coal transport vehicles. This paper presents a general scheme of intelligent coal transport vehicle system. The control system of the intelligent coal transport vehicle takes the programmable controller (PLC) as the core, connects the general analog input module through the programmable controller to complete the acquisition of the required sensor signals and control the coal transport vehicle to complete the planned operation. The system uses the new energy battery as the power, which is 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 consists of main controller (PLC), various sensors (hydraulic sensor, inclination sensor, collision sensor, etc.), control objects (walking motor, steering motor, braking hydraulic pump, solenoid valves for braking) and touch screen. The 4ad2da module realizes the acquisition and conversion of analog input signal and the output of walking motor speed control analog. The steering position encoder is used to practically feed back the current steering angle data, and its data and battery status data exchange data with PLC through RS-485 communication.

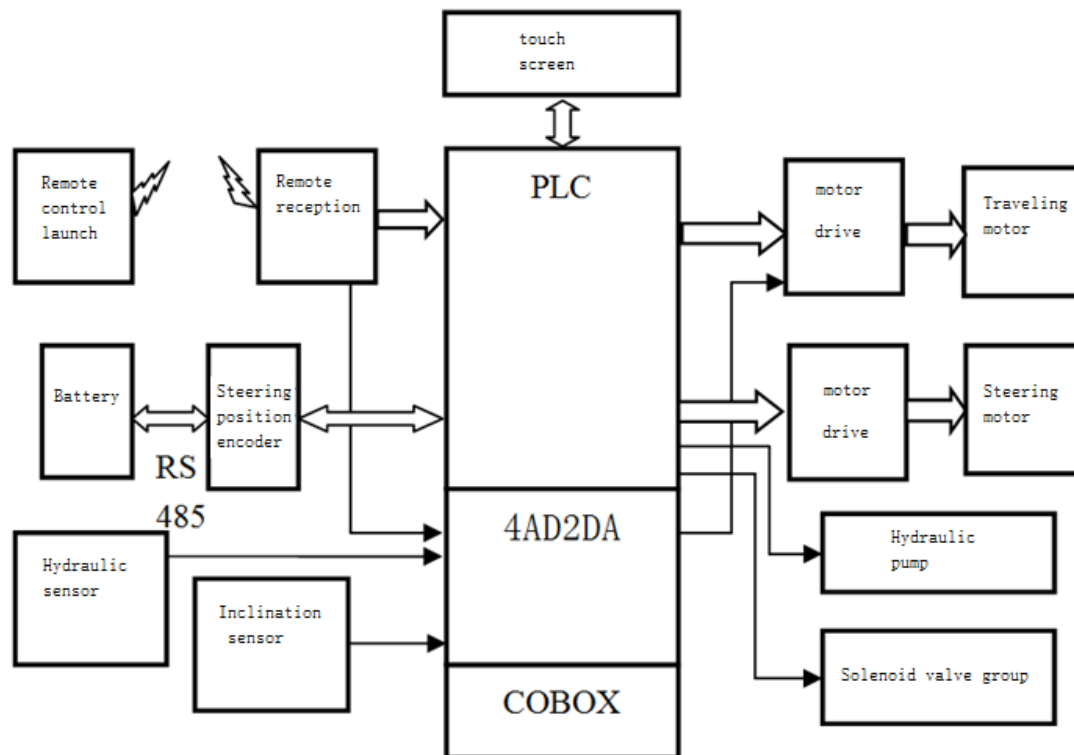


Figure 1. System block diagram

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 operation program, travel program, steering program, braking program, alarm program, etc. Modular design is to design and develop the control program by means of functional programming and separate implementation, that is, first write a single functional program, debug and realize it, gradually complete the programming of all functions, and then string all control functions.

3.2. Input / Output Port Assignment

Set 14 input interfaces and 14 output interfaces.

3.3. PLC Control Program

3.3.1 Free communication program

The free communication program realizes PLC to read the angle signal of photoelectric rotary encoder and read the battery status information. Among them, Fig. 2 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 degrees. D300 ~ d307 store the sent command data 01 03 00 00 01 84 0A. Send sends data instructions for the serial port. RCV D310 K14 K2 is the serial port data receiving instruction, and the received data is placed in the 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 it in the d102 register. Figure3 is a ladder diagram for reading battery status data.

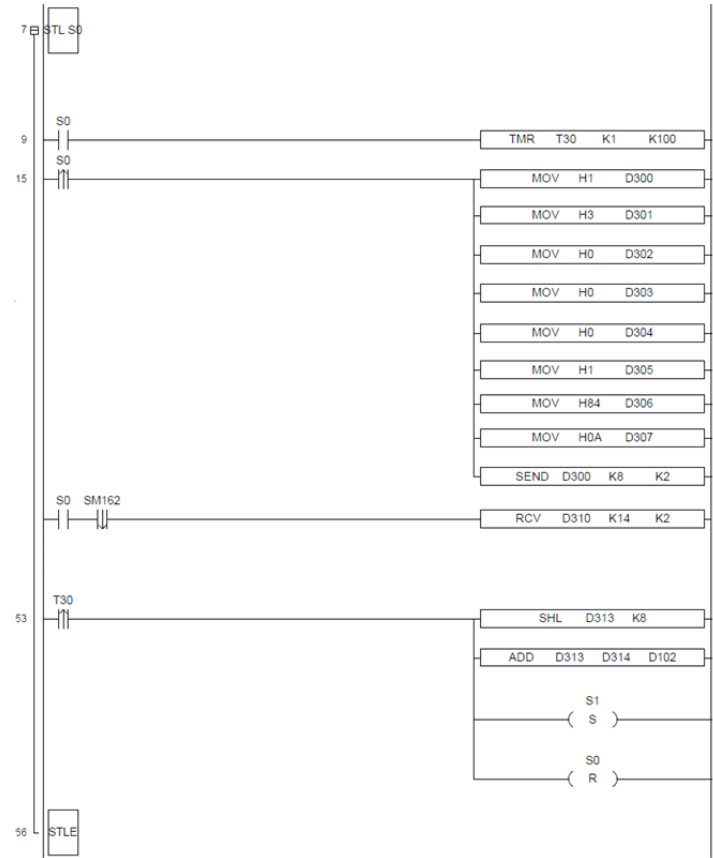


Figure 2. Ladder diagram of reading encoder data

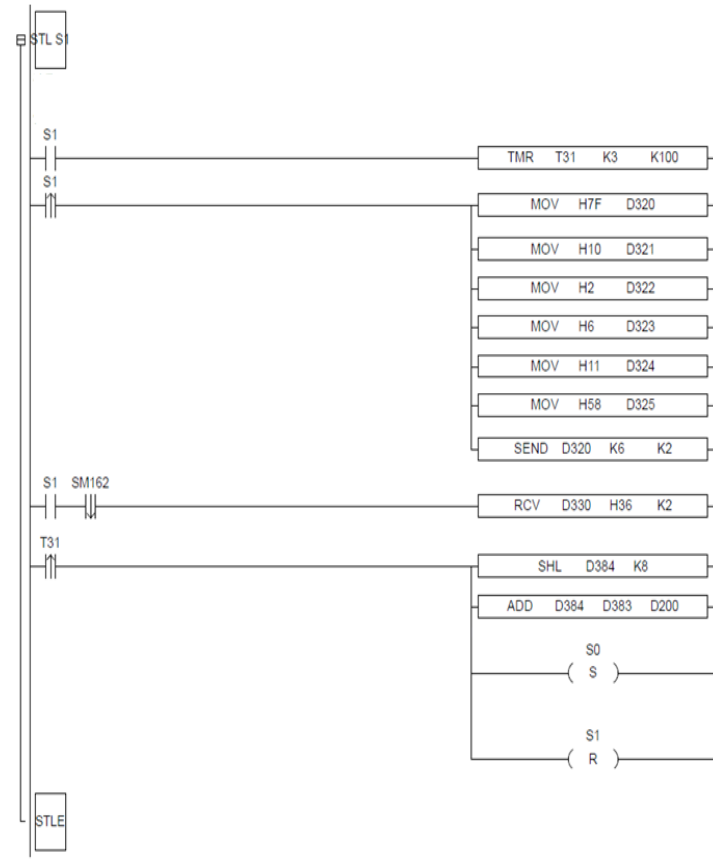


Figure 3. Ladder diagram of reading battery status data

3.3.2 Analog initialization processing and operation program

Analog initialization processing and operation program PLC ladder diagram is shown in Figure 4. Realize the numerical conversion of analog data, input and output enable, etc. The analog module ad input channel 1 is connected to the brake oil circuit oil pressure transmitter, the oil pressure value (0 ~ 16383) is stored in register D2, and then converted into the pressure value (kg / cm²) through calculation. The floating point number is stored in D4 and the integer number is stored in D6. The analog module ad input channel 2 is connected to the inclination transmitter signal, and the corresponding data is stored in d34. The remote control speed value is input through ad channel 3 and stored in latch register HD0 after processing. Y10000 ~ y10002 are enable control signals of analog input AD1 ~ AD3.

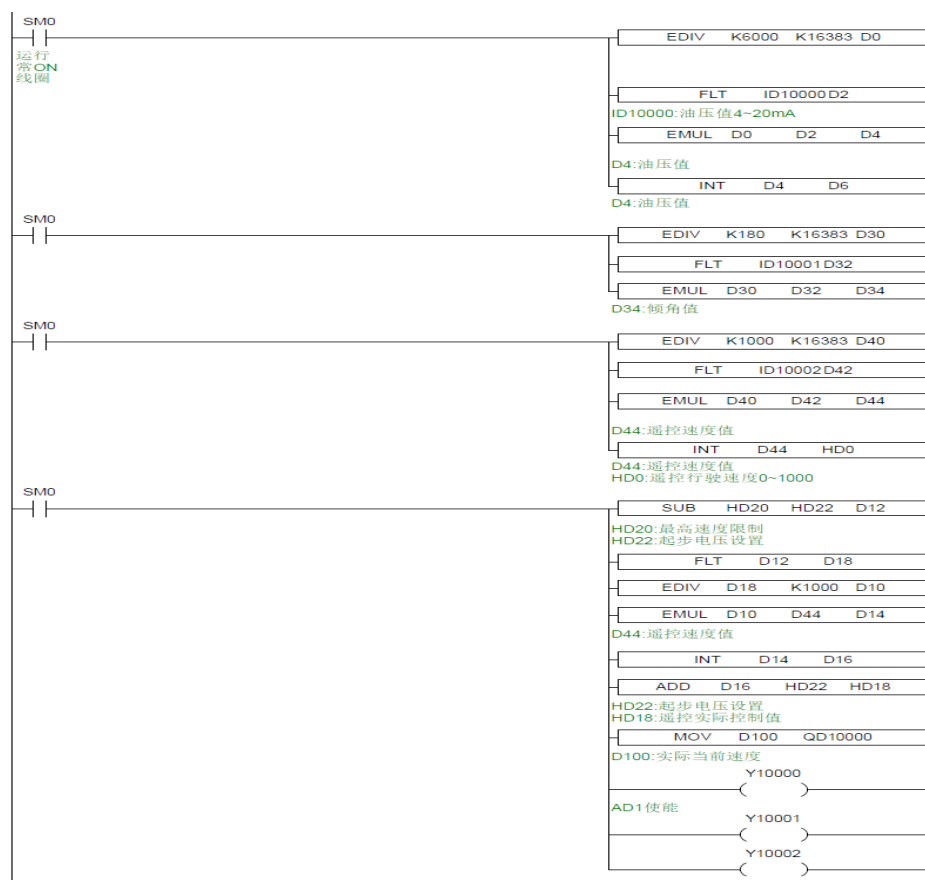


Figure 4. Analog initialization processing and operation program

3.3.3 Travel procedure

The traveling procedure 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 and Y3 controls the motor direction. When Y3 has a signal, it is forward, and when there is no signal output, it is reverse (backward). Figure 5 shows the forward execution procedure. Figure 6 shows the control program of the backward action of the intelligent coal truck.

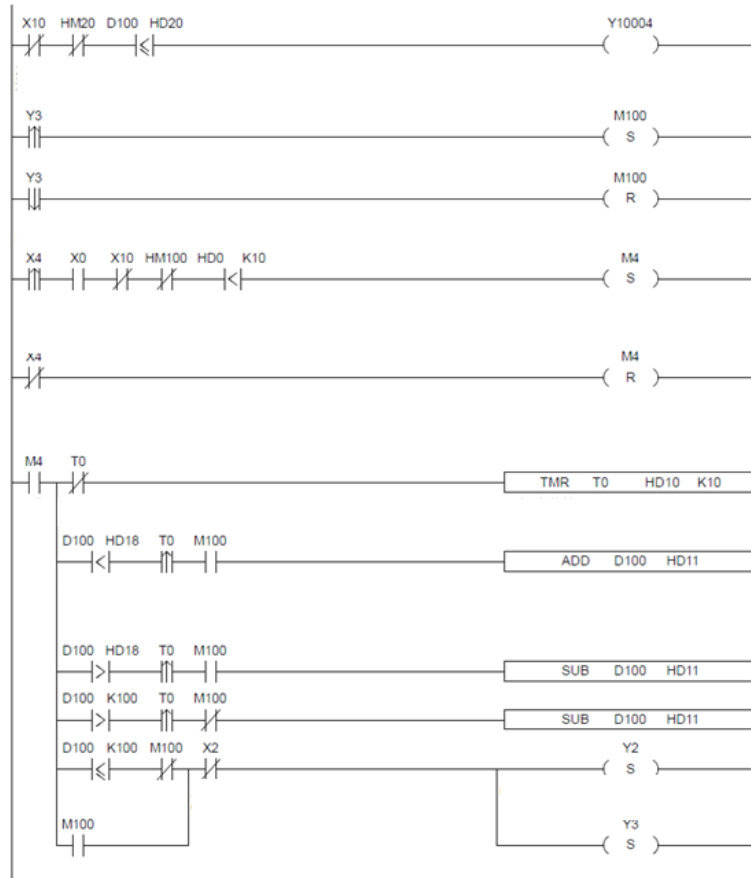


Figure 5. Forward control program

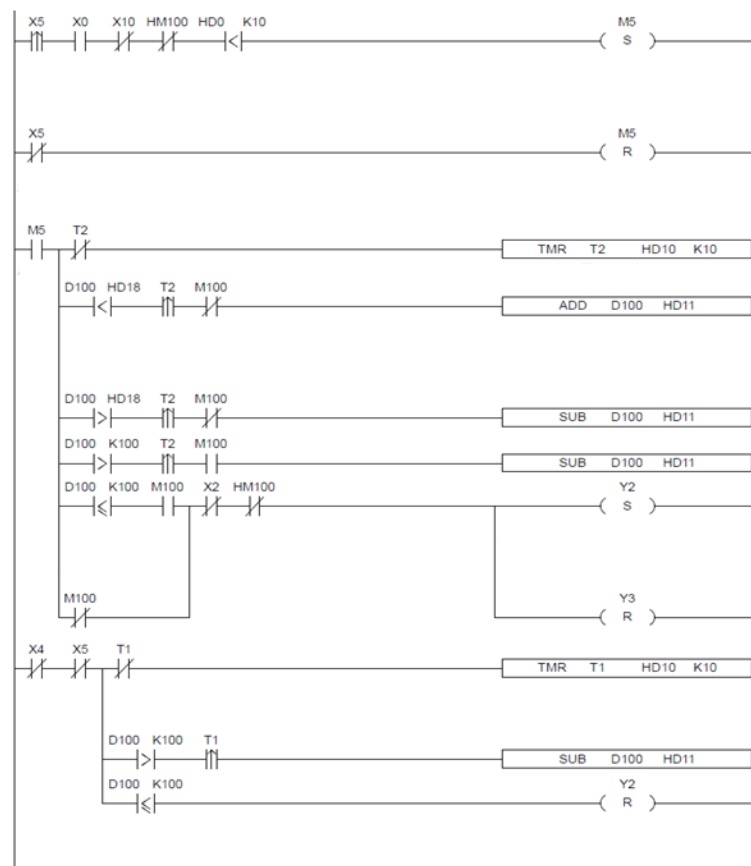


Figure 6. Backward control program

3.3.4 Steering procedure

In the program, Y0 output control turns left and Y1 output control turns right. The hd3 register stores the angle value of the photoelectric rotary encoder when going straight ahead. The current rotation angle value is compared with the rotation angle value when going straight to determine whether the steering angle is left or right. At the same time, the maximum angle is limited. The leftmost angle value is stored in HD2 and the rightmost angle value is stored in HD4 to realize the soft limit of steering.

4. Software Debugging of Intelligent Coal Transport Vehicle

When the hardware debugging and testing of intelligent coal transport vehicle are completed, the software debugging shall be carried out. On the open ground, the intelligent coal transport vehicle is operated by remote control to control the forward, backward, left, right and speed. Check whether the working procedure meets the control requirements, and modify the procedure according to the phenomenon 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 met the design requirements. When the load is 2 tons, complete the working links such as forward, acceleration, left turn, right turn, deceleration, braking and so on, 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 vehicle status information, modify and set relevant setting parameters, and achieve the man-machine 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 communication service program of CANopen Protocol on the basis of this system. The authority management level is set, and the automatic driving upper computer generally has the highest control authority.

In this paper, only the collision parking braking link is set for the safe operation of coal transport vehicles. In terms of safety control, we can further study the addition of non-contact obstacle avoidance links such as lidar to improve the safety level.

References

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