Design of Control Device for Mine Endless Rope Winch

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Abstract—This paper introduces the composition, working principle, hardware and software design of the control device of the economical mine hoist rope winch.The device is controlled by the main control box.For the core, real-time detection of speed signal and winch running information, and can be real-time display of information on the touch screen, with winch start and stop, is reverse control, speed regulation and automatic deceleration control, head and tail over volume, Kai cars warning, turnoff alarm function; when winch fault immediately to stop.To ensure the safe operation of the winch. The device can be used as the soft starter or the direct starting control system of the non pole rope winch, and can be used as the frequency control of the winch without pole rope winch system.

Keywords- endless rope winch; economical control device; automatic control; speed sensor; over volume switch; touch screen; voice alarm

I. INTRODUCTION

Endless rope winch has a large carrying capacity, mining area, down the mountain and centralized track Lane etc. driving circuit materials, equipment can reach and other characteristics, is the relay mode of transport, to achieve weight, light integral hydraulic support and all kinds of mine material transport a than the ideal transport equipment instead of traditional small winch. With the wide application of the endless rope winch, the technology of the control device of the rope winch is becoming more and more mature, and the competition of the market is becoming fiercer and fiercer. In order to improve the market competition ability of the rope winch device, the author has developed an economical mine winch control device with no pole rope. The device is no ZWK127 type mine very rope winch control device to improve product designed to Taiwan in the form of operation, compact and reasonable layout, good man-machine interface and user-friendly operation. At the same time, it has the characteristics of low cost, stable and reliable, and can be used as the soft starter or the control system of the non pole rope winch, and can be used as the frequency control system of the winch without pole rope.

II. DEVICE COMPOSITION AND WORKING PRINCIPLE

Wherever Times is specified, Times Roman or Times New Roman may be used. If neither is available on your word processor, please use the font closest in appearance to Times. Avoid using bit-mapped fonts if possible. True-Type 1 or Open Type fonts are preferred. Please embed symbol fonts, as well, for math, etc.

Conomic type mining very rope winch control device by the operation panel, a speed sensor, a volume switch, touch screen, a main control box, the voice warning unit, the block diagram as shown in Figure 1.

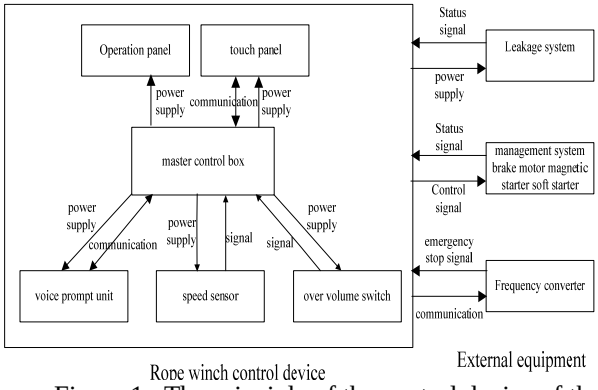

Figure 1. The principle of the control device of the rope winch

The device to a main control box as the core, the operation information of real-time detection and the speed signal of the winch, sent to the touch screen display, the realization of the winch of start, stop, control, positive and negative, speed regulation and automatic control of acceleration and deceleration, with head and tail volume, speed, slip, off the road, along the emergency stop etc.

protection function, and increase the management, call, car alarm, alarm fork, pedestrian unsafe area photoelectric induction locking stop function. When the winch appears the fault can stop immediately, and ensure the safe operation of the winch.

III. HARDWARE DESIGN

A. Oeration panel

The operating panel is a window of human-computer interaction, and the panel has different configuration according to the control object.. Starting and stopping, ascending, descending, resetting, fault releasing button and a self - locking emergency stop button is the essential standard button in the panel. If the control device is used for the control of the converter adjustable speed winch, the panel will increase the speed adjusting handle and load and light load selector knob.

B. Speed sensor and over volume switch

Speed sensor by the induction magnetic steel pulse, the pulse is sent to the main control box is calculated to achieve the winch speed, real time monitoring location and owe or ultra speed, head and tail soft limit protection.Nose, tail and starting position put a roll off switch, winch operation to the starting position and touches the switch, so as to realize the position clear, prevent the generation of cumulative error, resulting in dislocation parking; head and tail to roll off switch on the winch overwind protection function, main control box once has been detected volume signal, immediately stop, to prevent accidents.

C. Touch screen

The touch screen for safety and flameproof, mainly by the touch control board, LCD screen and communication isolation board. The touch screen can overcome the disadvantages of the original display, such as the need for external keyboard, the operation is not convenient, etc., with the winch running information real-time display, communications receiver processing, protection node type settings and other functions.

D. Main control box

The main control box is composed of a main control board, intrinsically safe power supply, switching power supply, its structure as shown in figure 2. The main control board is the CPU CortexM3 as the core control unit, power supply consists of intrinsically safe power supply, switching power supply power supply separately, input and output all intrinsically safe interface, with isolation protection of dual channel RS485 communication interface. With the status of the lock save unit, the CPU running on the fly or reset when the last time to run the information to ensure that the work is stable and reliable.

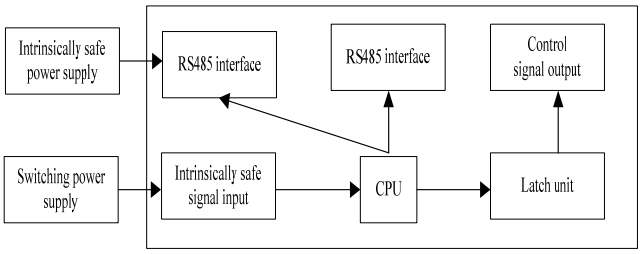

Figure 2. main control box structure

E. Voice reminder unit

The voice reminder unit receives the status information from the main control box through the RS485 communication interface, and has the function of fault alarm reminder, parking reminder and so on. When the winch operation to the uphill, downhill, corners and other key positions, the unit will automatically send out voice prompting signal remind operator corresponding acceleration and deceleration control, to ensure that the winch at a safe speed through the key points [4]. When the winch fails, the warning information is issued at the same time as the emergency stop, so that the operator can notify the operator in time.

IV. DEVICE SOFTWARE DESIGN

Economic type mining very rope winch control device for each component are related software, some parts is very rope winch control device has been used in parts ZWK127 type mine, here is no longer introduced the software functions the, the following key introduction touch the software design of the display screen and the main control box.

A. Touch screen software design

Touch screen software uses MCGS 6.5 configuration software design, winch operating status information to simulate animation form is reflected in the man-machine interface, operation personnel can view the winch operating position and velocity trajectory, all kinds of state information through human-machine interface. At the same time, it can enter parameter setting interface switch input type setting, modify the winch operating trajectory distance, line point setting, such as setting uphill position, downhill position, turning position, set volume type switch, speed sensor pulse width etc.. Touch screen operation main interface as shown in Figure 3, in the main interface click on the parameter settings button to enter parameter setting interface and various parameter settings and save; click track configuration button can winch running track, distance and the key points of the set.

B. Main control box software design

The software of the main control box is written in C language, and the module is designed, including the following parts: initialization procedure, communication program, status detection program and control program. The initialization procedure is the initialization of various peripherals and states, with registers and state latch functions, and maintains the status information before

reset. Communication program using RTU Modbus, with communication interrupt protection function, once the communication interruption, can immediately send a quick stop signal, to ensure the safe operation of the winch. The status detection program uses the sequential scanning mode, real-time detection of the running state of the winch, and sends out the control commands to the control program module. The control program uses the state machine structure design, when the control program module receives the control commands issued by the state detection module, according to different commands into different control state. The status of the control program is shown in Figure 3.

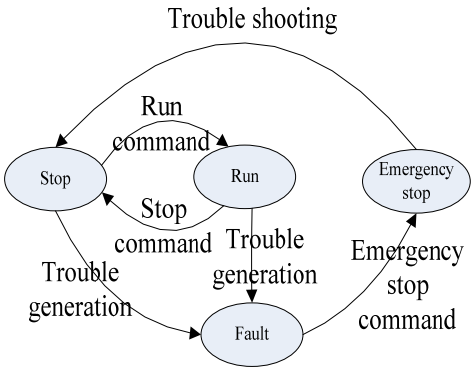

Figure 3. state machine diagram of the control program

V. USE EFFECT ANALYSIS

A. *The system has strong adaptability to the roadway section.*

The original design of the mine at the beginning of the Wang Zhuang coal mine is still in use, and there is no increase in the section. No very rope winch and dispatching winch supporting use constitute a transport system, without the need for a new roadway, using the return air lane will be able to meet the transportation needs.

B. *Compared with other equipment, the performance is reliable and the cost is low.*

Past the mine also launched a rail cars and tooth rail car card, Inka rail car of roadway support request is high, and the installation cycle is long, difficult installation and spare parts consumption, single class with minor volume, more vehicles reversing difficult restricts the production and tooth rail car fuel consumption, noise, Cheng Yunliang single was lower, longer transport time, climbing ability is limited, and on the mechanical maintenance workload, key equipment price is high and is not easy to complete, seriously affect the production of transport, are not able to withstand the test of practice have been eliminated, after the transformation of no very rope winch to overcome the above disadvantages.

it is more suitable for the use of the roadway in the fully mechanized face..

The very rope winch overall fixed on a flatbed truck, in the use of fortune to the point of use, installation on the end of a rail fixed with steel wire rope eye punch, rail head pressure column to prevent head tilt. In the tunnel, the general column fixed the small tail wheel, the wire rope is pulled open, the middle rope climbing vehicle, and the whole installation process is completed.. When the normal operation of the fully mechanized coal face is normal, the tail wheel can be carried out at any time, and the short wire rope can be reused on the dispatching winch.

C. *Can meet the needs of large tonnage bracket transportation.*

Supporting the use of the car even tight rope hook, in practice by hanging before and after the hook method to solve the transport of big tonnage support requirements, can meet the requirements of the slope of large and long distance transportation. With the continuous use of large tonnage bracket, the rope free winch from JW - 500 JW, /33 - 950 /48, -1200 /60 JW, JW - 1600 /80 until JW - 2100 /100 type of continuous upgrade. In the large slope over long distance, JW - 2100 /100 winch can give full play to its strengths.

D. *the transmission of the information of the visual language management signal.*

In recent years, in the process of using the endless rope winch, along with the continuous extension of the mining area, the transmission of information more difficult. Therefore, in Wang Zhuang coal mine with Handan mining machinery plant research and development of the language of the acoustic signal dotting and on line signal to implement transfer carrier, does not affect the original sound and light signal system, practical, and solve the difficulties in the past only RBI cannot communicate with language to communicate with each other, the use of stepless rope winch, a menace, the practicability is improved.

E. *transportation efficiency is high, safety performance is good.*

Use endless rope haulage system can production line, to ensure in time complete transportation task of large workload, avoid because of heavy workload and lengthen the operating time caused by induction operator fatigue phenomenon, effectively guarantee the safety in production. Especially, the more load transportation task of the super long distance, the more the efficiency of the transportation task is demonstrated..

VI. CONCLUSION

The endless rope winch is mainly used for roadway transport, inclined roadway is generally applicable to the angle of less than 8 in the. The equipment can adapt to the complicated conditions of the slope fluctuation and bending, and can also adapt to the long-distance transportation of the roadway in the coal mining face, and can change the distance of transportation along with the advancing of the coal face..

At present, with belt conveyor as the main system of coal and the roadway to bolting direction, mine to normal reduce the amount of supporting materials. At the same time, the expansion of the size of the mine, increasing equipment tonnage, no very rope winch practical is superior to other auxiliary transport equipment.

The device is very suitable for large-scale mine deep far well, continue to be recognized and accepted, will become the preferred equipment for mine auxiliary transport system improvement and optimization.

Due to the fast speed of mining in fully mechanized coal mining face, no rope winch need to keep moving, installation, so we adopt the very rope winch first fixed on a flatbed truck, and then fixed to the vehicle on the track way. This way not only the installation of high efficiency, and is labor-saving and time-saving, strong applicability.

Economic type mining very rope winch control device is very rope winch control products to improve the device without ZWK127 type mine, both in hardware circuit and structure are of the simplified and very good control of the product cost, improve the market competitiveness of the products. The device not only can be used as polar rope winch of soft start or straight rev control system, but also can be used as the endless rope winch frequency control system, realizes the control of no very rope winch to start, stop, heavy load, light load, uplink and downlink frequency conversion stepless speed regulation, and has over flow, overvoltage, overwind and overspeed, slipping, RBI emergency stop and various protecting functions. When the winch failure can immediately stop to ensure that the winch safe operation.The performance test shows that the device runs stably and reliably, and achieves the expected design target.

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