Fault location system of belt conveyor based on CANopen protocol

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Abstract. In order to resolve these problems of the long belt conveyor that the fault is not easy to locate, the location efficiency is low, the maintenance cost is high and so on, a design scheme of the fault location system of belt conveyor based on CANopen protocol was proposed. The basic model of CANopen device was introduced, the communication network structure of system was built and the application process of CANopen protocol in the fault location system of belt conveyor was analyzed minutely, then a test system was built to verify the feasibility and superiority of the scheme. The results showed that: the structure of the fault location system based on CAnopen protocol was more simple,and possessed higher reliability and stronger compatibility.

Introduction

With the expansion of industrial production scale, belt conveyor system is developing forward the direction of a longer distance. The existing fault location system of belt conveyor already can not meet the needs of practical applications. The common methods of fault location include resistor network and DIP switch location [1]. But the former can not solve the problem of the conflict of multiple fault points. If directly use the second method, it will require a lot of cables to complete a fault location system that can increase construction difficulty and cost. The fault location system of belt conveyor with CAN bus technology based on CANopen protocol can not exist the above problem, and it will be more reliable, its real-time character and compatibility also will be more strong.

The basic model of CANopen device

CANopen protocol is an application-layer protocol based on CAN bus. In foreign countries, it has become the most important communication standard among various industrial equipment. The basic model of CANopen device includes a communication unit, object dictionary and the user application, the basic model of CANopen device is as follows:
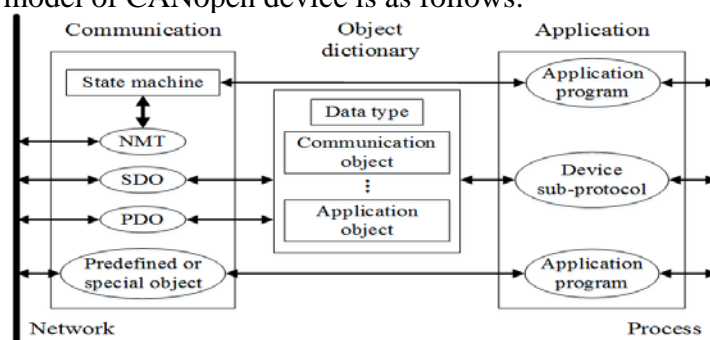

Fig. 1 Basic model of CANopen device

In figure 1, the communication unit consists of a CAN transceiver, CAN controller and CANopen protocol stack. In CANopen protocol, four types of objects that NMT, SDO, PDO and predefined messages or special function object are defined to achieve data transmission, network management, emergency disposition and other functions[2].Object dictionary is a core concept in CANopen protocol, which is the interface between the user application and the communication unit, and it is an ordered objects group, each object is addressed by using a 16-bits index, in order to access to the individual element of a data structure, an 8-bits sub-index is defined[3]. The user

applications are the definitions and descriptions of basic functions of device, besides implement the appropriate device sub-profile, the specific practical applications of device are also included [4].

Communication network structure of fault location system of belt conveyor

In order to ensure the reliability and response speed of the system, the entire system is designed with multi-master and multi-slave to achieve subsection control, then all sections are combined to meet user requirements. Since a single CAN bus can accommodate 110 nodes at the most[5], for long distance belt conveyor, the number of the protective devices distributed along it is usually much more than 110. The subsection control is to divide the whole network into a large number of small independent networks, which a single CAN bus can drive, then each small network is regulated respectively by using its own only master stations, and all of the master stations are supervised by the PC to achieve the purpose of supervising the entire network.The system structure is as follows:.
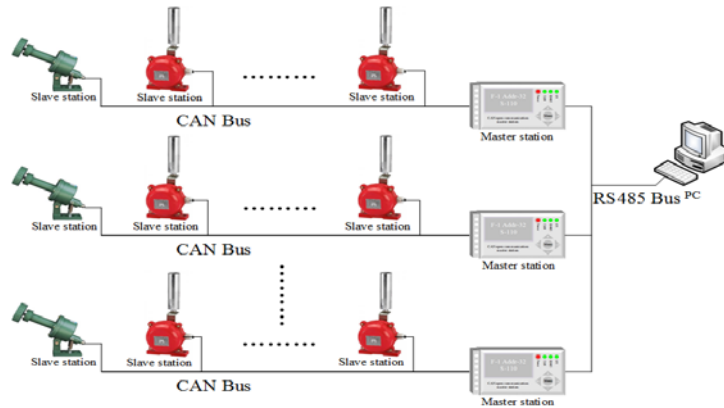

Fig. 2 Structure diagram of communication network

Implementation of CANopen protocol of fault location system of belt conveyor

CAN bus communication circuit. CAN bus communication circuit mainly consists of the PIC microprocessor, photon-coupled isolator and CAN bus transceiver. PIC18F25K80 has integrated the CAN bus controller, which greatly simplifies the design of the communication circuit. 6N137 that high-speed photon-coupled isolator improves the anti-interference performance. PCA82C250 is used to be the interface between CAN controller and the physical bus to provide differential transmitting capability for the bus and differential receiving capability for CAN controller. CAN bus communication circuit is as follows:.
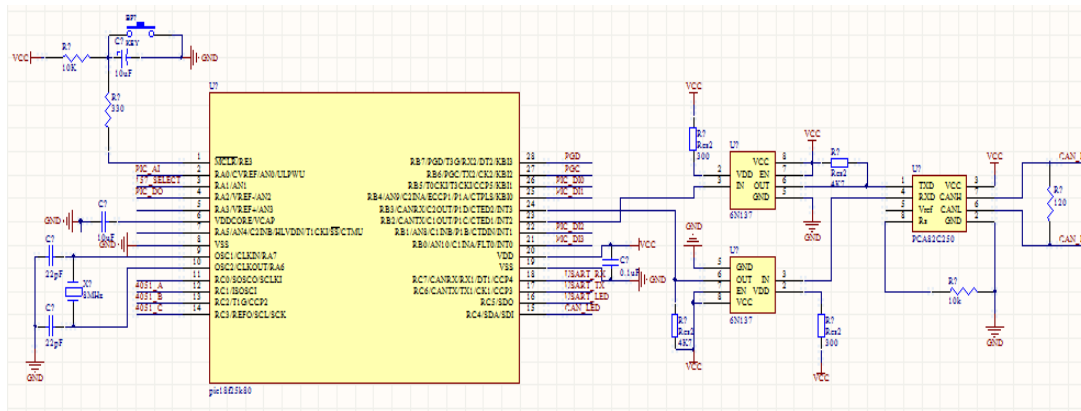
Fig. 3 CAN bus communication circuit

The allocation scheme of node ID. In CANopen communication network, the ID of CANopen device must be unique, it is a arbitration flag of data priority, and will directly response to the position information of fault points in fault location system of belt conveyor. CANopen defines a "Predefined Master/Slave Connection Set" to provide a default assignment scheme of CAN identifier for standard frame of 11-bits CAN-ID, in which the first 4 bits represent the function code,

the left 7 bits represent the node ID that ranges from 1 to 127, and 0 is the broadcast address[6]. The entire fault location system of belt conveyor is divided into multiple independent CAN bus network, each CAN bus network uses this default allocation scheme, then through different master station, the same node ID under different CAN bus network can also be distinguished. Take the PDO communication as an example, the setting of master/slave PDO identifier is as follows:
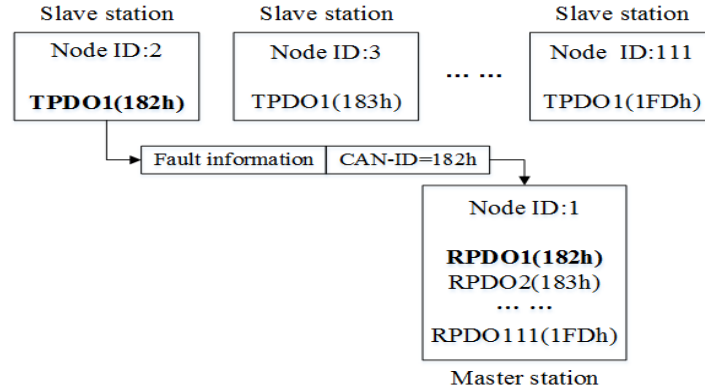
Fig. 4 Setting of PDO identifier of master/slave station

CANopen communication of master/slave station. Besides transmitting the fault information by PDO, the slave station also receives management and configuring information from the master station. The master station can achieve state switching of the slave station by NMT, and it must also be able to implement to read or write the object dictionary of the slave station by SDO. In order to achieve the purpose that the master station can real-timely monitor the slave station, the heartbeat packets mechanisms of CANopen protocol is implemented. The slave station regularly report the current state to the master station. If the master station does not receive a heartbeat message from the slave station in the predetermined time, the master station will give an alarm. The flow chart of CANopen communication program of master station is as follows:
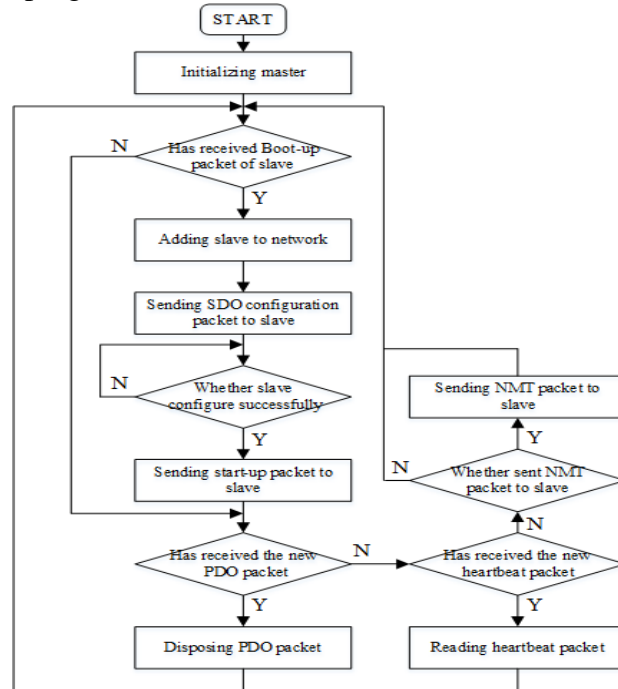
Fig. 5 Flow chart of CANopen communication program of master station

Experimental results and analysis

In order to assess the feasibility of the system, the analysis platform of CANopen protocol is simulated to be the master station to test CAN bus communication based on CANopen protocol with the slave station by using USB-CAN adapter. The results are shown in Figures 6.

Figure 6 is the data display based on CANopen protocol. After initialing, slave station automatically enter the pre-operational state. The master station sends "Start_Remote_Node" packets to the slave station by NMT, then the slave station enter into the operational state, in this state, the slave station supports all CANopen communication services. No.1 is that the master station sends "Remote_PDO" packet to request the TPDO transmission of the slave station. After receiving the remote request, the slave station transmits its own TPDO mapping application data by TPDO. No.2 and 3 are the transmission packets of slave station including the digital and analog data. In CANopen protocol, SDO client can read or write a single object in the object dictionary of SDO server. Reading is generally defined as "Upload", and writing is defined as the "Download". No.4 is that the master station issues a "Upload" request to slave station by the accelerated SDO, and No.5 is the answer from the slave station.

Fig. 6 Communication data display based on CANopen protocol

Summary

The fault location system of belt conveyor based on CANopen protocol can posse the higher reliability and greater compatibility. The test has proved that the system can achieve the basic communication services of CANopen protocol. Through real-timely detecting the various protective devices along the belt conveyor, the fault information can be timely reported to achieve a rapid fault location function and a hand-held terminal of address coding is designed to greatly simplify the system and save the cost, these ensure steady operation of the belt conveyor in a cost-effective way, and it is certainly significant to improve industrial safety production.

References

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