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Study Of Bearing Manufacturing Monitoring System Based On Double-Layer Field Bus

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Abstract—The difficulty in building the manufacturing monitoring networks for the bearing manufacturing is analyzed. Then the manufacturing network based on double filed bus is carried out. The network framework, network nodes construction and the communication protocol model is discussed.

Keywords- manufacturing monitoring Network Load, double field bus, communication protocol model

1. Introduction

Bearing is the basi components of the industry, its quality is very vital to equipments. In order to assure its manufacturing quality, the manufacturing monitoring system is a very effective way to assurance its quality. Although field bus has strong serviceability in manufacturing field, there are some challenges that hinder its application in some cases. The number of monitoring objects is more than the max load of the field bus is one of them. Aiming at extending the load of the field bus, the manufacturing monitoring system based on double field bus is carried out.

2. The manufacturing monitoring network based on double field bus

2.1. The construction of manufacturing monitoring network

The management stucture of the bearing enterprise is divided into three levels: the enterprise management level, the workshop management level and the site management level. So the manufacturing monitoring structure should be consistent with the management structure to supply the manufacturing data to support the decision-making of each level.

At enterprise management level, the network in bulit using ENW (Ethernet NetWork) which can connect to all the department of the enterprise and it discussed in many articals, so it is not discussed in this article. At workshop management level, the PLFB(PLANT LEVEL FILED BUS)is given. It is the fisrt level field bus. The network node on PLFB is called PT-2. It can supply the workshop manufacture information to workshop management organization. At the site management level, the ELFB (EQUIMPMENT LEVEL-FILED BUS) is given, it is the second level field bus. The network node on ELFB is called as TS-10, it has the functions of quaity data sampling and communicaiton and also can supply machine working information to the operators. The PLFB is the communicaiton birage between ENW and ELFB and there is a protocol interchager between ENW and PLFB.

As to bearing manufacturing, all the data would be transferred through the PLFB, so the data transmission ability should be the first priority. Here the FF field bus is used. Some the quality data such as equipment

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working cycle, maintenance and other data can be read form the equipment control system through RS485 or RS232 interface and the data from each equipment is relatively small. So the RS485 field bus is used to construct the ELFB networks. The manufacturing monitoring network framework is shown in Fig. 1.

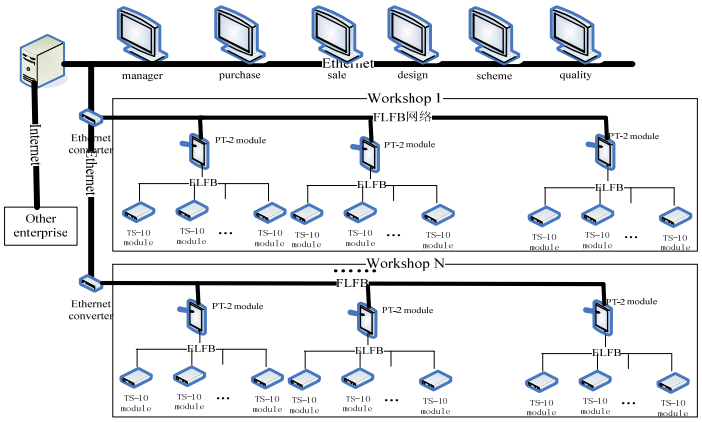

Fig.1. The structure of the bearing manufacturing system based on double field bus

2.2. The function module design of PT-2 &TS-10

The design of PT-2 and TS-10 abides the principle of unitized design. Accoring to the bearing manufacturing conditions, the embeded system is slected to develop the PT-2 and TS-10 moddule. The PT-2 module based on embedded system includes PNBDM(PLFB Network BUS drive module), ENBDM(ELFB Network BUS drive module), DSM (Data Storeage Module), MCU module with double UART tunnels, MMIM(man-machine interaction module) and PMCM(Power Matching & Control Module) which as shown in Fig. 2. The PNBDM implements the function of PLFB drviven and the ENBDM implements the function of ELFB driven. The MCU module has double UART channels and one of them connects to PNBDM module and the other connects to ENBDM module which constructs the communicaiton channel in MCU. The DSM is devided into three segments and called as DSM(Data Sent Mailbox), DRM(Data Recieve Mailbox) and DSA(Data Storage Area) respectively. By this design, it can achieve the goal of data receiving, sending, data compression, and storage without data confusion.

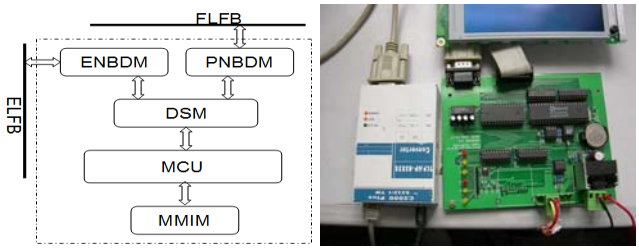

Fig.2. PT-2 module logical schematic diagram and sample

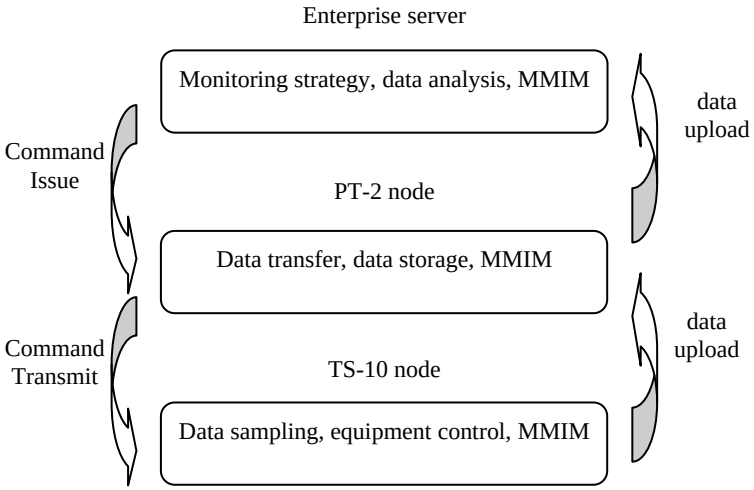

Fig.3. the data transfer logic

There is a ELFB network on each equipment which includes a series of TS-10 network nodes to implement the functions of qulaity data sampling, equipment working status contol and data commuincation with PLFB network.. The main function modules of TS-10 include ENBDM：ELFB Network BUS drive module, a series of PDICM (process data inpector & control module), MCU module, DSM, MMIM and PMCM. Except PDICM module, the other modules are the same with the PT-2. and these function modules can be reused derectivly.

By changing the field bus drive module and PMCM, the PT-2 and TS-10 can be used to different conditions. And the laod of field bus can be extended to N2 (N is the max number of field bus load) that can makes the field bus be useful in bearing manufacturing monitoring.

2.3. the generation of communication protocol model

The main data communication logic is the master-slave structure. In the ENW-PLFB level, the enterprise data server is the master node and PT-2 node is the slave node. But in PLFB-ELFB level, the PT-2 node is the master node and the TS-10 node is the slave node. When the slave node needs to implement data communication, it should request authorization from the master node at first which can avoid communication conflict. So the communication protocol is divided as the master communication protocol and the slave communication protocol. The master communication protocol includes the parameter setting command and data acquisition command (status data, fault data and parameter data). And the slave communication includes parameters setting feedback command, equipment control feedback command and data feedback command.

The master communication protocol and slave protocol have the same communication protocol model, it can be described as:

Communication protocol packet head(1) + command(2) + Communication protocol packet tail(3)

(1) Communication protocol packet head

In the head, there is an identifier word that describes the beginning and the type of theprotocol packet. Here, the code “FAH” means the protocol packet is send by the master node and the code “FDH” means the protocol packet is sent by the slave node.

(2)Command

There are three parts of content in protocol command. The first is the message receiving node indentification. The second is the command description of the command. And the last part is the command content.

1) node information:

This part identifies the message reciving node that is which node should implement the command and the other nodes should negelct it.

2) Command description

This part describes the meaning of a command. Normally this part is a code:

- 01H: Data acquisition command, that is the communication protocol is a data requset message to specific nodes;
- 02H: Parameters setting confirm, that is the communication protocol is a parameters setting message to specific nodes.
- 03H:control command, that is the communication protocol is a control message to specicfic equipment;
- 04H: status check command, that is the communication protocol is a requset for equipment or node working status message to specific nodes;
- 05H: feedback command that is the communication protocol is a respond message to a command.

3) Command content

This part is the content of a command. According to the command type, it may be parameters setting message, control command, status information or monitoring data.

(3) Communication protocol packet tail

There is check code generated by CRC algorithm and an identification code in the Communication protocol packet tail.

Using the data communication protocol, the enterprise can generate a communication protocol quickly according to the specific monitoring request and conditions.

3. Ease of Use

Taking a bearing enterprise in NingBo for an example, there are more then 50 grinding machines. And there are five parameters should be monitored: the processing cycle, diameter dimension, feed, vibration, noise, maintenance information and Wheel Dressing information. So there are more then 300 parameters should be monitored in total. And it is more then the max load of the field bus. So the manufacturing monitoring networks based double field bus is used.：

When the monitoring system operating, the communication protocol can be generated using the protocol model given in segment 2.3 to implement data communication. Taking the TS-10 node with the code 45H implement data upload for an example, it should make a request for authorization at first. The communication protocol packet is as following:

FCH 30H 45H 67H FDH

30H is the command type description, it means the TS-10 node has data to transfer to the PT-2 node and request for authorization.

FCH is the head of the protocol packet and FDH is tail of the packet.

67H is the check code generated by CRC algorithm.

And the corresponding PT-2 node communication protocol packet is as following:

FAH 45H 86H 35H FDH

86H is the command descrition; it means the data transfer authorization is granted to the TS-10 node with the code of 45H.

FAH is the head of the protocol packet and FDH is tail of the packet.

35H is the check code generated by CRC algorithm.

When the TS-10 node gets the authorization， it transfers the data to corresponding PT-2 node:

FCH 32H 80H 97H 13H 01H 20H……59H 85H FDH。

32H is the bearing part code, it means the inside ring

80H and 97H are the code of ring batch;

13H is the process code. It means the finish lapping process;

01H 20H……59H is the monitoring data;

Other protocol is the same, according to the quality information communication need; the protocol can be generated qulickly by the protocol model given in segement 2.3.

4. Conclusion

The manufacturing monitoring system based on double field bus carried out in this article can extend the field bus load effectively. And its deveplopment process abides by the principle of modular design which makes the manufacturing monitoring networks has strong extensive applicability and low system development and maintance cost.

5. References

[1] Fiona Zhao, Xun Xu, S.Q. Xie. Computer-Aided Inspection Planning-The state of the art. Acta Automatica Sinica, Volume 35, Issue 3, March 2009, Pages 233-238

[2] Martin Oppermann, Wilfried Sauer, Heinz Wohlrabe． Optimization of Inspection Strategies by Use of Quality Cost Model and SPC． ISSE, Calimanesti-Caciulata, Romania, May 5－9， 2004

[3] N.V.R. Naidu. Mathematical model for quality cost optimization. Robotics and Computer-Integrated Manufacturing. Volume 24, Issue 6, December 2008, Pages 811-815

[4] Rodrigo J.P. Ferreira, Adiel Teixeira de Almeida. A multi-criteria decision model to determine inspection intervals of condition monitoring based on delay time analysis. Reliability Engineering & System Safety, Volume 94, Issue 5, May 2009, Pages 905-912

[5] Jie C, GreinerR, Kelly J,et al. Learning Bayesian network from data: An information-theory based approach[J]. Artificial Intelligence, 2002, 137: 43-90.