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A Multi-parameter Grain Detection System Based on Industry 4.0

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Abstract

A multi-parameter grain detection system based on industry 4.0 was used to map all kinds of sensors and devices into multiple network addresses through the integration of equipment, to realize the local visual perception and the network transmission of various grain data, using software plug-in architecture technology to build online extension of the software to achieve the corresponding grain multi-parameter monitoring plug-ins; setting sensor and device communication protocol standards to achieve remote monitoring of various grain situation data on the scene equipment Remote debugging and maintenance work to form a remote data center and equipment maintenance center. The system is compatible with a wide range of heterogeneous sensors and devices online and with a high degree of online scalability.

Keywords: grain detection system; Industry 4.0; the integration of equipment

Introduction

The grain detection system is a system that uses modern electronic technology to detect, store and analyze ecological parameters of stored grain. The current system has major problems such as single function, poor compatibility, poor extension capability, and low level of intelligence. The design architecture lacks systemic considerations. It is difficult for different manufacturers and different kinds of data to be integrated in one system. The system integration of different sensors and equipment is difficult and incompatible, and it is unable to achieve integrated collection, control and data transmission, and it is no longer adaptable to new demands.

The stored grain detection system implemented in this paper is an information system under the Industry 4.0 architecture. It relies on the heterogeneous sensor universal access hardware platform and integrated equipment deployed in the field to achieve real-time perception of multiple stored grain condition data and cooperative control field equipment, intelligent system based on this platform can achieve continuous evolution and upgrade of the system, use of big data technology to analyze the correlation relationship between sensor data, accurately extract characteristics of stored grain, and form an online extension and maintenance of the stored grain detection application system, the core of which is compatible with a variety of heterogeneous sensors and devices online, has a high degree of online scalability.

System implementation

Overall design structure of system

The system design adopts the idea of automatic evolution and divides the system into four subsystems: (1) universal access hardware platform and integrated equipment for the front-end granary; (2) software system for the grain depot monitoring center; (3) background data and maintenance center software system; (4) stored grain condition big data analysis application platform. as shown in Fig.1.

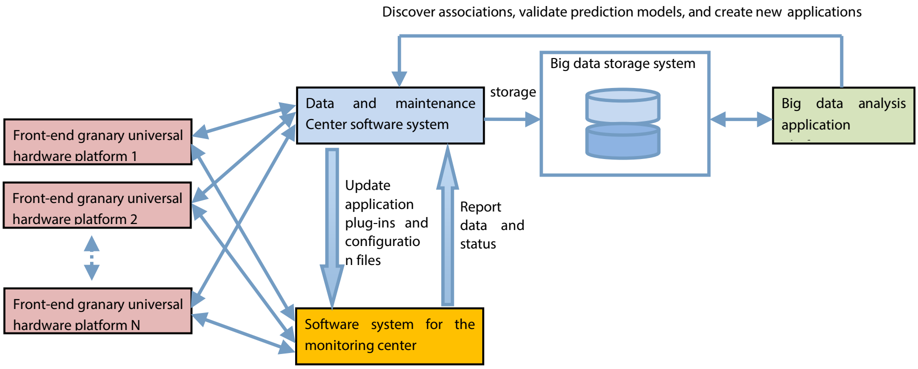

Fig.1. System Design

Each front-end general hardware platform and integrated equipment is installed in one granary, and is responsible for connecting different sensors and control devices according to user needs. Its design adopts the concept of Industry 4.0 and maps various on-site sensors and control devices into independent IP addresses. All sensors and devices can communicate over Ethernet, thus shielding the heterogeneity of various sensor and device communication physical layers. In addition, the heterogeneity of the communication protocols of different devices is packaged and transparently transmitted using the communication protocol packaging technology. This platform can also push data to different data terminals at the same time, and allows legitimate login clients to perform remote device debugging.

The software system for the grain depot monitoring center is a core software platform installed in the local control room of the grain depot. It adopts a full plug-in framework and can be upgraded to adapt to different sensors and devices through automatic plug-in upgrade. The service can be upgraded by authorizing download of the latest application.

The background data and maintenance center software is responsible for receiving and analyzing data from different sensors and electromechanical devices. It has a monitoring function and stores the data in a large data storage system. This software system is developed using a full plug-in framework and the system can adds and updates newly developed plug-ins and pushes the plug-in to the user software system for the grain depot monitoring center that purchased the application.

The stored grain condition big data analysis application platform is used to find out the relationship between sensor data in data analysis, develop prediction models, promote the development of new applications and plug-ins, and provide users with new services.

Design and Implementation of universal hardware platform and integrated equipment

"Universal hardware platform and integrated equipment" includes a general hardware interface platform and a field integrated equipment, as shown in Fig.2.

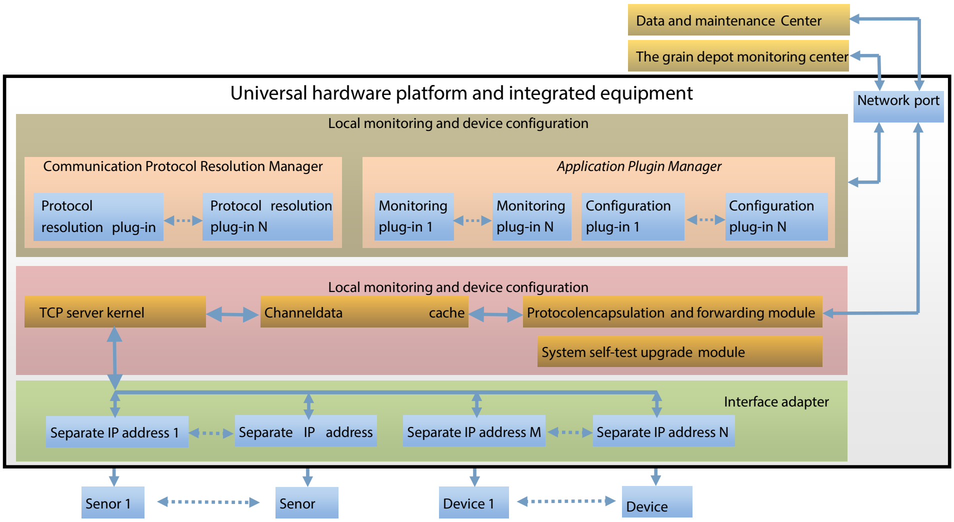

Fig.2. Universal hardware platform and integrated equipment Design

The universal hardware interface platform connects different sensors and control devices according to the user's needs. Its design uses the idea of the Internet of Things to map various on-site sensors and devices into separate IP addresses. All devices communicate through the network. It shields the heterogeneity of communication and physical layers of various sensors and devices, adopts the secondary packaging technology of communication protocols to transparently transmit data of different devices, and facilitates the rapid deployment of new sensors or devices in the future; while taking into account the local monitoring of stored grain conditions The data can also be pushed to different data centers at the same time to form a source node of big data information that can adapt to the future development.

The integrated equipment adopts an integrated industrial control computer running Windows operating system. The application program adopts a framework structure and plug-in mode. The developed application program has strong reliability, flexibility, and compatibility. It realizes the on-site visual display of stored grain condition data and system configuration and high-speed and flexible network data transmission. The software has an online upgrade function.

Software system for the grain depot monitoring center

"Software system for the grain depot monitoring center" is a software platform used by users. It adopts a full plug-in framework to develop and adapt to different sensors and equipments through automatic plug-in upgrade. At the same time, it can remotely apply for authorization to the data center and download the latest ones. The application of stored grain condition is used for online upgrades, as shown in Fig.3.

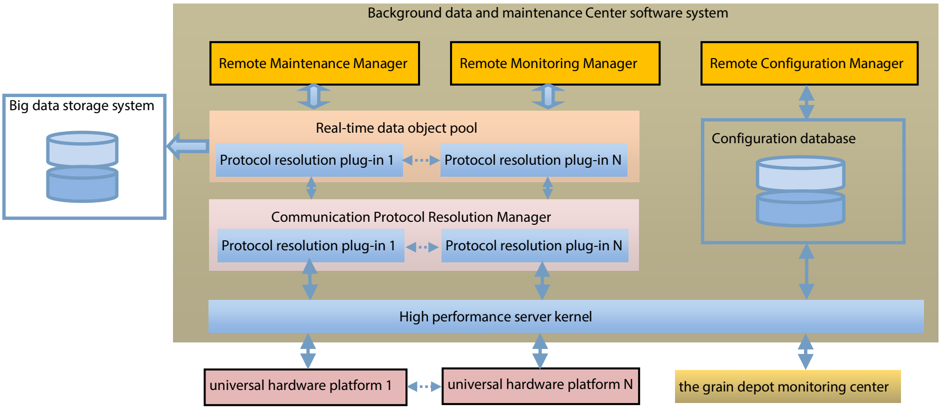

Fig.3. Software system for the grain depot monitoring center

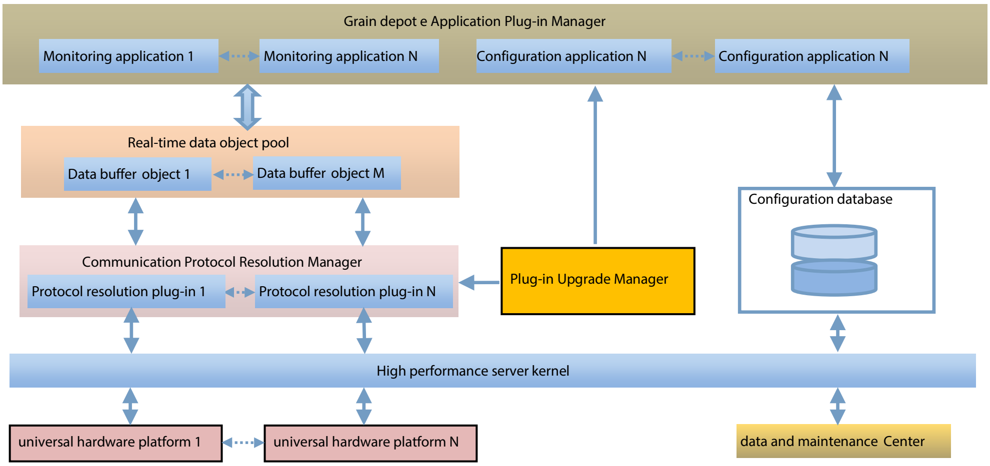

Fig.4. Background data and maintenance Center software system

Background data and maintenance center software system

"Background data and maintenance center software system" is a software platform installed in the data center. It is responsible for receiving and analyzing the transparent transmission data sent from different granaries of each grain depot. The system is developed with a full plug-in framework. Each plug-in can correspond to different field devices. In the data center, all the data information in the grain depot can be remotely monitored, and the equipment can be remotely commissioned and maintained in a transparent transmission mode to form a maintenance center. A variety of new application softwares are developed for application release on this platform; data from grain depot are stored in the big storage system to form an internal data center, as shown in figure 4.

Stored grain condition big data analysis application platform

"Stored grain condition big data analysis application platform" is used to find out the correlations among sensor data in the stored grain condition big data storage system based on hadoop, to develop prediction models, and to promote the development of new applications and plug-ins to form new high-additions to users. The value service is delivered to users through the " Background data and maintenance center software system ".

Conclusion

The system adopts a universal network platform design. Upgrading the front-end sensors and equipment will not affect the system. It only requires the development of relevant interface plug-in dynamic links. The system software of the data and maintenance center is developed by the plug-in architecture, and the system function expansion only needs to replace or add different dynamic connection blocks, which has good scalability. With the universalized front-end design, the integration process for installing or upgrading different sensors or devices will be standardized. With remote on-line device debugging capabilities, and the system is very maintainable. The system provides data mining tools based on historical data, finds the relationships among data, develops prediction models, and optimizes configuration information. A sustainable and intelligent evolutionary system is finally formed, which can generate value for users for a long time.

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Global establishment risk of stored products beetles

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Abstract

Stored-product beetles were regarded as some of the most important stored-product pests in the world. Predicting which one in hundreds of potential invasive stored-product beetles is the most likely to invade a region presents a significant challenge. A global presence/absence dataset, including 201 economically significant stored beetles in 143 countries/regions, was analysed using a Self-Organizing Map (SOM) to categorize regions based on similarities in species assemblages. This method is able to rank these stored-product beetles based on risk of establishment indices (values between 0 and 1). From the six countries/regions selected from each continent, we can have an overview of the global invasive risk of this group of beetles. We also found that those countries geographically close were clustered together by the SOM analysis because they have similar beetle assemblages and therefore represent greater threats to each other as sources of invasive stored-product beetles.

Keywords: stored-product beetles, Coleoptera, self-organizing map, establishment risk

The stored-product beetles (Coleoptera), include more than 300 species in 40 families and cause about 85% of stored pest damage (Zhang et al., 2015). These taxa are of quarantine significance since the beetles are usually small in size, have a broad host range, and have a high reproductive ability and dispersal capacity, and, in addition, the grain depot can offer a stable environment and abundant food for the establishment of alien species. For example, *Trogoderma granarium* originated from Asia, was first reported in California in 1953, where it caused 220 million dollars in loses amounting to 10% of income from agricultural products (Chu et al., 2008). Predicting which one in hundreds of potential invasive stored-product beetles is the most likely to invade a region is of significant importance for global trade policies such as China's 'Belt and Road' program.