Big data collection and application based on 5G Industrial Internet Three-level edge layer

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Abstract—The project is based on 5G+ Industrial Internet to collect the "three-level" edge layer: equipment integration and multi-source heterogeneous data of spare parts manufacturers, equipment manufacturers and equipment users, complete the assimilation of multiple heterogeneous data, establish a unified data standard, and eliminate Discrete enterprise characteristics. Focusing on the informatization of upstream power equipment which is taking into account the informatization of downstream inventory power equipment and realize a large-scale and shallow informatization project of incremental equipment in the Yangtze River Delta in a short period of time, thereby helping companies build general services at the SaaS layer around equipment data. Develop the best process plan to serve enterprise customers in the industry.

1. INTRODUCTION
The project is oriented to areas with high concentration of manufacturing resources and urgent needs for industrial transformation. With industrial motors as a breakthrough, through 5G+ edge layer equipment cloud technology, the "three-level" edge layer regional key equipment cloud and data communication are opened, and electronic sensors are used. Embedded technology multi-source heterogeneous data conversion and analysis technology to complete multiple heterogeneous data assimilation processing in order to achieve quantification, normalization, standardization, spatialization, discretization and other data information granulation, which is forming a unified data standard[1-3].

Relying on equipment data and informatization, master key evaluation information, and carry out large-scale standardized application maturity evaluation; through regional production data collection, a competitive radius model and horizontal comparison mechanism are formed, and a list of key equipment operating performance is produced; through real-time production data Cross-analysis with process efficiency, combined with the construction of the platform PaaS layer mechanism model library, produces the best process plan, and serves industry corporate customers[4-5].

2. SYSTEM OVERALL STRUCTURE DESIGN
Focusing on "5G +'three-level' edge equipment + data communication + service platform", considering the customer's cost sensitivity, the scale of the service target enterprise, and the principle of being close
to the actual production and application of the enterprise, focusing on the "three-level" data collection and Application to carry out work. The 5G networking mode is shown in Figure 1.

Figure 1: The 5G networking mode

1) Data collection terminal
   Develop a general-purpose hardware integration system compatible with LTECAT1/CAT4/5G communication capabilities. The software system development can be customized to serve customer needs. The underlying Linux driver is the main body, the embedded industrial APP is integrated, and the on-board industrial APP is pre-installed. Adaptation is required Database and API calls. Through the deployment of intelligent data collection terminals, information such as electrical equipment and OT operators can be collected in real time.

Figure 2: The Data collection system

2) Collecting terminal interconnection CPE
   Through the CPE and the data collection terminal for network interconnection, the collected data can be interconnected with the 5G public network. The smart motor is connected to Huawei CPE via WiFi signal, and the CPE receives the 5G signal sent by the base station[6-7].

Figure 3: The collecting terminal interconnection CPE

3) 5G+CPE network formation
   The 5G+CPE method is adopted for enterprise coverage networking, and a 5G network that can cover small and medium-sized enterprises is established to ensure that the coverage problem of the customer group can be solved stably and reliably.
4) Data service platform
Aiming at "three-level" edge equipment customers, develop an industrial big data service platform, and provide a background management system to view the production and operation status of the number of online motors, the total number of equipment, the total number of operations, and the total number of shutdowns; for the average working time, the status of the switch equipment and the after-sales service Perform statistical analysis of data to provide predictive maintenance services for equipment under real working conditions monitoring; provide industry control group process improvement strategies based on industrial big data analysis.

3. SOFTWARE SYSTEM OVERALL DESIGN

3.1. Data Collection of Intelligent Motor Embedded Terminal
In view of the operation process of the motor, the monitoring of its electrical parameters is very common. At present, the mainstream technology mostly uses split-type sensing equipment, which is temporarily installed when needed. This discrete sensing device is not integrated with the motor, and has defects such as large volume, high cost, and poor intelligence. In addition, the space in the motor junction box is narrow, and the electromagnetic, temperature, vibration and other interference generated during the operation of the motor can easily cause interference to the sensing equipment in the narrow space of the junction box.

This project uses a variety of technical means to integrate the motor operation data acquisition equipment in the motor junction box to solve various possible interference problems. First of all, in the data acquisition and preprocessing link, the noise filtering process is added to eliminate the large influence of the current harmonics generated by the motor on the variance of the measured data, and a high-performance AD converter is used in the analog-to-digital conversion process; In the power supply link of the data acquisition module, in order to eliminate the harmonics and possible surges generated during the operation of inductive loads such as motors, anti-surge circuits and harmonic filter circuits are designed; in order to improve the electromagnetic compatibility of the equipment, a metal plate The space in the inner box is divided into upper and lower independent spaces, and the multi-sensor data acquisition circuit is specially designed to improve the anti-interference ability of the signal path and the coupling filtering effect of the power circuit. At the same time, it collects data from strong electric circuits and multi-sensors. The equipment is distributed and assembled reasonably in space to eliminate the influence of mechanical vibration on the reliability of the equipment; in order to reduce the influence of the increase in motor temperature on data acquisition, the acquisition front-end circuit adds a temperature compensation function. After a large number of preliminary tests, the test results show that the designed embedded data acquisition equipment has good monitoring performance and stable reliability. The structure diagram of the intelligent motor product is shown in Figure 6.
3.2. Multi-source heterogeneous signal data conversion analysis

The diversity of sensors in the Industrial Internet leads to the multi-source heterogeneity of industrial data. How to use a unified standard to accurately analyze data and solve the protocol compatibility issues of different manufacturers and different electrical control systems will be one of the important issues that need to be resolved to realize the industrial Internet.

This project comprehensively considers the multi-dimensional joint features composed of multi-source heterogeneous data time-domain features, frequency-domain features and time-frequency features, and realizes accurate data analysis through the mutual supplement of information between various features. First, extract the time-domain, frequency-domain and time-frequency features of specific data to construct multi-dimensional joint features of the data; then use the feature selection method based on dynamic genetic algorithm to realize multi-dimensional joint feature selection, and adopt the method based on principal component analysis (The feature fusion method of PCA) to reduce the dimension of multi-dimensional joint features to reduce information redundancy; finally, cluster analysis of data feature values, and use deep learning methods based on deep convolutional neural networks to classify data features through feature signals Classify and judge the equipment type and processing type to realize the correct identification of equipment data.

The technology used in this project compares the bottom-level characteristic signals of the equipment with a large number of real data experiments, sets independent signals of industrial equipment and industrial production data fusion quality control standards, designs and completes the analysis and fusion tasks for industrial production signals, and transforms the underlying equipment signals It lays the foundation for the structured equipment big data under specific needs and the subsequent application of industrial data.

4. INTERFACE DISPLAY

The Industrial Technology Research Institute of Changzhou Vocational College of Information Technology is responsible for scientific research and technology research and engineering technology verification. The consortium Changzhou Tianzheng Industry is responsible for industrial incubation and technical services. Changzhou Telecom is responsible for 5G network coverage and optimization.

4.1. Parts Manufacturer-Southern Motor Sales Service Platform

Changzhou South Electric Co., Ltd. has an annual output value of 300 million yuan, has 80 agents across the country, hundreds of equipment corporate customers and sells about 600,000 electric motors each year. The project consortium will cooperate with South Electric in 2019 to carry out digital transformation. Assist in the development of new products "smart motors". Through the data access of the new product intelligent motor, the South Motor equipment management cloud platform was customized and developed for the South Motor. The platform function modules are described as follows:

①Basic enterprise data

The platform uploads basic data information such as Southern Electric Company's profile, corporate honors, product certificates, and intellectual property certificates to the cloud for classified management,
so that users, company managers and platform users can see the company's basic information at a glance.

②Maintenance tracking

The platform builds an after-sales service business platform for Nanfang Electric, tracking every "smart motor" product sold by Nanfang Electric. Customers can choose the equipment to be maintained at the client for telephone repair or online repair. The online repair application is submitted by uploading the fault photo, the type of equipment failure to be repaired, and the fault description, and then submits the online repair application; the user can view the repair in progress and the completed repair through the client. Complete maintenance equipment information, realize the information management of equipment maintenance, improve equipment management efficiency, and reduce various risks caused by inadequate maintenance. At the same time, it is set to automatically remind users to check and maintain production equipment to ensure the healthy operation of the equipment and reduce unplanned failures of the equipment. The display interface of the Southern Electric Platform is shown in Figure 6.

4.2. Equipment manufacturer-Qingyuan Laser

This project provides a large number of service modules in the digital transformation and upgrading platform, and provides corresponding drag-and-drop services for each equipment manufacturer. Take Qingyuan Laser as an example. The main business of Wuxi Qingyuan Laser Technology Co., Ltd. is the R&D, manufacturing and sales of laser cutting machines. Qingyuan Laser selected some modules from the digital transformation service resource pool and built a background management system for laser equipment. The back-end display interface of the equipment manufacturer is shown in Figure 7.

Equipment manufacturers can view the total number of online devices, the total number of operations, and the total number of shutdowns through the background management system. At the same time, the average working hours of yesterday, the status of the equipment on and off and the after-sales data are statistically analyzed. The equipment that is found to be abnormal can be operated remotely, and the company name, product name and purchase time can be obtained by clicking online to facilitate effective problem solving.
4.3. Equipment user-Linadi

This project provides a large number of service modules in the digital transformation and upgrading platform, and provides production visualization platform services for every equipment user. Changzhou Linadi Intelligent Technology Co., Ltd. is a high-tech modern enterprise dedicated to precision sheet metal parts, precision laser cutting, plastic spraying, electronic communication equipment, complete sets of mechanical and electrical equipment, mold design and development, and assembly product services. Mainly for customers in industries including new energy, automobiles, rail transit, communication equipment, textile machinery, medical equipment, cabinet and chassis manufacturing. The interface of Changzhou Linadi Intelligent Technology Co., Ltd. intelligent management and control platform is shown in Figure 8.

![Figure 8: The Linadi intelligent management and control platform](image)

The intelligent management and control platform for the production workshop of the enterprise covers all the equipment on the production site. According to the production data of the equipment, it provides modules for employee productivity utilization and employee performance management this month, effectively improving the internal management level of the enterprise and improving the production efficiency of the enterprise.

5. SUMMARY

Due to the small scale, the domestic motor terminal manufacturers have few product varieties and small batches. This paper puts forward the cloud construction of "three-level" edge layer equipment for 5G, and realizes the "three-level" edge layer: equipment integrated cloud implementation solutions for parts manufacturers, equipment manufacturers, and equipment users. At present, the business has been extended to Central China and North China. In the next three to five years, it will gradually deploy the national market and strive to increase its market share to about 20% nationwide. At present, the "5G + 'three-level' edge device + data communication + service platform" model has been actually promoted in many factories, and the solutions are also widely welcomed. The future market scenario is expected to be huge.

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