Design of a Network-integrated Data Acquisition Instrument of Gas Station Based on ARM Linux

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ABSTRACT

The Network-integrated data acquisition instrument (NDAI) of gas stations is designed and developed on ARM Linux platform, by using technology of computing, network, database and internet of things. Combined with algorithms of oil leakage detection, non-stop refueling class-settlement, and adaptive optimization, the instrument acquires data at the second level from gas station of liquid level meter, control system, oil machine and other systems, and then it processes the acquired data, shares real-time data to the data centre, integrates multiple gas station data information, forms a unified, integrated and smooth information flow to meet the various application management and decision support. This work aims to realize the automation and intellectualization of the gas station, implement the visualization of business process, optimize the original function of the management system, improve the efficiency of management, maintain its independence from other original systems of the gas station, ensure the safety of the original data, and protect the original equipment investment.

KEYWORDS

Informatization and intellectualization, Data acquisition, Real-time monitoring.

INTRODUCTION

With the increasing pace of economic globalization and the transformation of the mode of economic development, and the urgent needs of adjusting and optimizing the economic structure, it is necessary to further promote oil companies to accelerate the pace of reforms so that their core competitiveness can be continuously improved. Developing modern industrial systems and integrating information technology and industrialization is the only way to promote China's industry. The 12th Five-Year Plan indicates that the oil companies should 1) enhance their own management level and the requirement on business execution efficiency, 2) integrate effectively of a large number of heterogeneous information systems, and 3) improve the level of data exchange and information sharing among systems as well as the business processing efficiency, thereby enhancing the service and support ability of information systems in the field of enterprise business and management. At present, with the rise and application of new technology in China’s petroleum retail industry, the automation and informatization of the gas station has reached a certain level, such as the automatic level of gauge station automation systems and video monitoring.
Due to the lack of data sharing among systems, there are information island problems. The application of the Network-integrated data acquisition instrument (NDAI) can break the information island, form a unified, integrated and smooth flow of information, and achieve information timely and accurately.

This work will contribute a lot for oil companies reaching the following Three Targets: informationalized management, automated management, and meticulous management. For example, Sinopec gas station retail network has the features such as large quantities, wide geographical distribution, uneven local gas station conditions, different levels of company surrounding environmental requirement, large difference of oil sales between different oil types, and different ownership of gas stations. This work takes into account all the above situations, in order to achieve the overall demand of systems, the management requirements of vertical management systems, and the management goals of horizontal management systems. At the same time, NDAI just upgrades the gas station of original GKS. More specifically, it maximally keeps the investment of the enterprises in equipment, guarantees the original production data security, and greatly reduces the risk of the enterprise applying products.

PHYSICAL ARCHITECTURE

Network-integrated data acquisition instrument (NDAI) in order to master and slave relationship link (generally 2-3 gas stations), oil machine and Network-integrated data acquisition instrument USES a serial port connection to transmit data, on the liquid level meter is equipped with Zigbee wireless module, and the Network-integrated data acquisition instrument of Zigbee module for wireless communication.

Local gas station Network-integrated data acquisition instrument acquisition and preprocessing data, and shall submit the required data to the GKS and uploaded to the data center, data center is responsible for the integration of all the gas stations in the area of data acquisition instrument upload, meet all kinds of application data management system requirements.

Network-integrated data acquisition instrument of physical architecture view is shown in Figure 1.

Figure 1. Physical architecture view.
HARDWARE DESIGN

Network-integrated data acquisition instrument (NDAI) hardware design mainly consists of acquisition instrument module design and Zigbee wireless module design (see Figure 2).

Integrated data acquisition instrument module design is based on the popular embedded system design idea nowadays, core chip with Samsung's 32-bit RISC processor S3C2440. provides a rich in the internal equipment at the same time, also integrates the function of many on-chip, greatly reduce the system cost, eliminates the need for additional device system configuration, provides low price and low power consumption, also is very high-performance small micro controller solution. Peripheral circuit including: power supply, real-time clock, JTAG, SD card, Ethernet front-end ports, serial port, USB port, LED lamp, etc.

Zigbee technology is very popular in internet of things; it can achieve the short distance wireless communication by this technique. It mainly uses the latest CC2530 chip as master chip for wireless module, at the same time application RFX2401 power amplifier chip to improve wireless module communication distance and signal strength, to ensure the integrity of the data security transmission. CC2530 and processor S3C2440 chip connect by internal serial interface ².

SOFTWARE DESIGN

Network-integrated data acquisition instrument software design is mainly composed of three parts: multiple serial port data acquisition, data storage and query, data analysis ⁵. At present, it has achieved multiple serial port acquisition tankers every clinch a deal the record and real-time monitored data of oilcan liquid level meter; Solved serial byte stream data set of calibration, data packets, packet analysis processing, data storage and other technical problems, designed Class-settlement balance and time balance algorithm, through the access to database, generated balanced Class-settlement report and time balanced report, the gas station oil enters sells saves the equilibrium analysis (see Figure 3).

- Class-settlement report preprocessing module
  - Complete the real-time collection of the information of the real-time to collect oil gun information by the Network-integrated data acquisition instrument, the oilcan liquid level and the oil gun trading information, according to non-stop refueling class-
settlement algorithm, gas stations calculate class-settlement regularly, provide data basis for generating the class-settlement report.

- Database operation module
  This is a logic module, and the specific codes are embedded in the other modules respectively, which are used to visit the database and query information, as well as writing the collected data and the processed data into the database.

**RUNNING ARCHITECTURE**

Uart_Server process on the master integrated data acquisition instrument is responsible for receiving the request, the data is written into the sqlite database, or query the database and return a result set;

Uart_Client process on the master integrated data acquisition instrument is responsible for collecting oil machine data and forwards the data through the socket to Uart_Server process on the master integrated data acquisition instrument;

Liquidlevel_Server process on the master integrated data acquisition instrument is responsible for receiving the request, the data is written into the sqlite database, or query the database and return a result set;

Liquidlevel_Client process on the master integrated data acquisition instrument responsible for collecting tank data and forwards the data through the socket to Liquidlevel_Server process on the master integrated data acquisition instrument;

GK_Client process on the GKS is responsible for requesting the data query process to Liquidlevel_Server service on the master integrated data acquisition instrument (see Figure 4).

Figure 3. The software schematic diagram.
PERFORMANCE INDICATORS

Real-time monitoring of oilcan and liquid level information\(^7\), for the second time precision level, liquid level precision is 0.1mm.

At the same time with 9600 BPS eight serial data acquisition, packet loss rate lower than 0.1%.

With 9600 BPS to second-class data acquisition of oilcan, packet loss rate lower than 0.1%.

Master Network-integrated data acquisition instrument can drive three slaves NDAI at the same time.

INNOVATION POINTS

Using Network-integrated data acquisition instrument real-time to collect oil gun information, the oilcan liquid level and the oil gun trading information, Through as shown in the figure below process can complete class-statement. According to the requirements of gas station, regularly calculated automatically class, so as to achieve the following effects:

- Optimize the business process, promote the business management standardization.
- Simplify business operations, improve the work efficiency.
- Humanized service, improve customer refueling experience.
- Provide efficient class-statement mechanism, flexible response to the gas station all kinds of class-statement strategies.
- Can eliminate the error due to the oil gun on the final settlement results brought, improves the accuracy of class-statement.

CONCLUSION

Network-integrated data acquisition instrument adopts ARM technology, Linux technology, Zigbee wireless sensor network technology and database technology as
the core, which fully embodies the integrated application of the correlation techniques of information and electronic. V1.0 version has been produced for a period of running. During the process of running, it realizes the original designed functions and performance index, satisfies the need of daily operation of gas stations, and achieve good practical results.

The Network-integrated data acquisition instrument has the capability of second-class collection of the relevant data of the oilcan and the oil machine. Besides, it can optimize bandwidth by the adaptive method to adapt to the bandwidth limitations, and use the bulk data way to write into database, thus forming a complete database, which lays a foundation for data integration and report output. The Network-integrated data acquisition instrument is easy to operate and maintain, and behaves well in interactivity. Moreover, the security, completeness and accuracy of data are guaranteed via multilayer techniques.

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REFERENCES