Research on the Intelligent Monitoring System of Oil Wells Based on Internet of Things

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Abstract: This paper proposes the design ideas and implementation plans of intelligent testing system of oil rigs based on Internet of Things through analyzing the status-quo of oil rigs and combining the up-to-date technologies of Internet of Things and artificial intelligence regarding the existing problems with oil rig detection. The system mainly studies data analysis and processing, oil rig safety monitoring, layers and structure of testing system, functions of master monitoring computers and on-site data collection among other content. The system enables effective precaution against potential safety hazards and real-time monitoring on the well site, effective data collection and analysis, so as to guarantee the safety of the oil well site and staff, and lay a solid foundation for the development of oil well sites.

1. Introduction

1.1. State-of-the-Art of Oil Rigs

Currently, on the basis of global digital electronic control technology, the electronic control system of intelligent oil rigs has entered its research and technical development stage. In recent years, competition in oil industry is becoming increasingly fierce, and it is imperative to lower the costs of exploiting oil and maintaining the safety of the oil well site. Therefore, it appears particularly important to research new oil rigs, as the rigs currently used in China are comparatively aged, and the way of controlling lags behind, leading to long cycles of well drilling, high damage rate of drills and great safety hazards.

1.2. IoT(Internet of Things) Technology

With the rapid development of sci-tech economy, people tend to obtain and control various resources and information on the production site in an automatic and intelligent way, particularly in terms of controlling the numerous parameters of hazardous equipment out of reach of manpower. The appearance of IoT[1] brings great convenience to people's life and work. IoT[2] makes use of sensing technology and intelligent devices to sense and identify the physical world, and realizes information exchange and seamless connection between man and object, through network transmission and interconnection of network, calculating, processing and excavation of knowledge, so as to achieve the goal of real-time control of the physical world, accurate management and scientific decision-making.

Currently, editing oil rigs have the functions of testing and showing parameters, but they late deficient in the integration and intelligence of the testing system. Regarding the testing integration monitoring and intelligent control of the working parameters of engineering machinery, the design of an intelligent monitoring system research based on multi-sensor fusion, an up-to-date technology based on IoT is proposed. The testing principles and plans are analyzed, and the composition of systematic hardware and software algorithm is elaborated, and finally the system is tested. The implementation of this project can improve the safety of oil well site work, guarantee the safety of staff and test whether there is any problem with machines in time, bearing great research value and significance.

2. System Design Thinking and Method

2.1. Main Viewpoints

Since the application of IoT technology to safe industrial production, the issue of safety has remained a critical and important issue in industrial production, therefore, attention to safety needs to be increased in automatic industrial production. As I oT technology is easy to position, and accurate positioning is feasible globally, meanwhile, the sensing function it has can effectively improve the safety of production, in the current process of automatic industrial production, safe production can be realized and actual production efficiency can be improved effectively in enterprises through reasonable application of IoT technology. In relevant industrial production equipment, the installation of relevant IoT equipment enables accurate positioning, and on this basis, guaranteeing the implementation of production at various links of enterprises successfully, and promoting the better development of industrial automation.

2.2. Basic Thinking and Methods

The system takes Lab windows of America's IN company as development tool, and it is equipped with functions such as measuring, monitoring traffic and temperature[3,4]communication and concentrated dispatch and management in the process of oil extraction. The system is has a multilevel distribution. SCMs and sensors working on each oil well comprise the first level, and the industrial personal computers in site make up the second level, while the master control detection computers of the production control center make up the third level.

3. Design of Intelligent Monitoring System for Oil Wells Based on IoT

On the basis of analyzing and researching the intelligent monitoring system of traditional oil rigs[5,6,7], this paper combines IoT technology and introduces intelligent safety monitoring system to the working system of oil drilling machines to improve the efficiency of the staff's discovery of problems with machines, thereby improving the safety of staff and stability of machines. The main content of the research in this paper includes:

3.1. Data Analysis and Processing

Reasonable need analysis plans are formulated through surveys followed by data processing[8]. The whole procedure is divided into four steps: Data Collection; Data Input/Pre-processing; Data Statistics/Analysis and Data Mining. The paper mainly involves calculation of existing data based on various algorithms, so as to make prediction and meet some needs of advanced data analysis. The design of algorithms mainly includes the three following parts: confirming needs, setting up models and iteration according to changes of users in time.
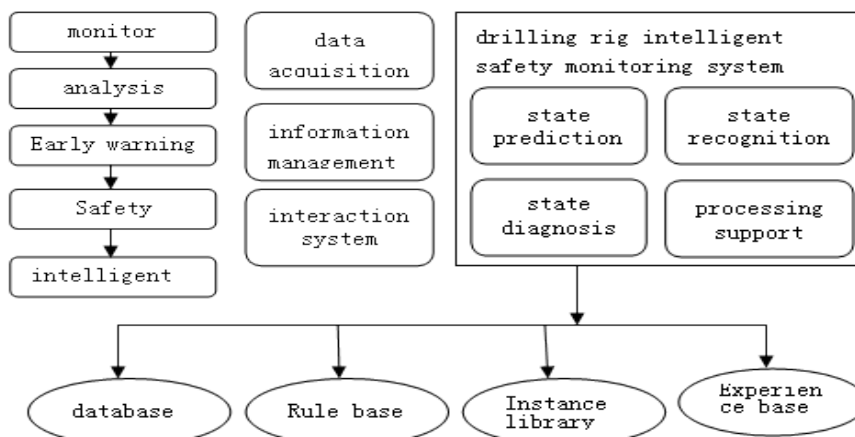
3.2. Safety Monitoring of Oil Rigs

Figure 1. Intelligent Monitoring System of Oil Rigs

3.3. Hierarchical Structure of the System

This system has a multilevel distribution. SCMs and sensors working on each oil well comprise the first level[9], and the industrial personal computers in site make up the second level, while the master control detection computers of the production control center make up the third level[10]. The first level of the system collects parameters such as traffic and temperature on site, many SCMs make up SCM network through on-site bus and field IPC communication; the main function of the second level is information transfer. It obtains data in the production process through communications with the SCMs of the first level, and transmits the data to the host computer of the production control center. Meanwhile, the level also has functions such as real-time display of parametric graphs, voice warnings and historical data inquiry; the third level is the computer of the main control monitoring station in the production control center. It communicates with various industrial personal computers and obtains production parameters through Wi-Fi. Meanwhile, it displays parametric graphs in real time, and has the functions of voice warning and historical data inquiry, capable of getting an accurate understanding of the production parameters in various oil wells and adopting corresponding measures to offer help.

3.4. Functions of Main Monitoring Computers

IBM is adopted as the main monitoring computer, equipped with DLINK aerials, DWL-900AP+ and omnidirectional antennas. It is equipped with functions such as real-time data collection and display, warning, historical data inquiry and textual communication. The programs of the main monitoring computer makes use of the programming platform in Lab Windows/CV of the American company of NI, and the function of communicating with the on-site industrial personal computers at the second level of the system is directly realized through transferring the TCP function library of Lab Windows/CVI , which is also part of the reason for adopting Lab Windows/CVI as the programming platform. The network protocol with the widest application in the Internet is TCP/IP protocol suite. TCP protocol is a transmission control protocol at the transmission level of TCP/IP protocol. The TCP function library of Lab Windows/CVI realizes the TCP services of TCP/IP protocol suite, and provides a port to winsock.dll.

The TCP function library in Lab Windows/CVI includes three sub-categories:

3.4.1. Server Function sub-category.

It is a server transmission controlling function capable of realizing registering and canceling servers, terminating connection with clients and reading and sending data among other functions.

3.4.2. Client Function sub-category.

It is a client-type transmission control function capable of connecting and disconnecting with servers and reading and sending data, etc.

3.4.3. Support Function sub-category.

It is an alternative supportive function capable of getting the name and IP address of local host computers and connected host computers, setting the way of disconnection and getting corresponding sockets through connection handles.

3.5. On-site Data Collection

The temperature and traffic sensors of the production site collect parameters on temperature and traffic and convert them into digital signals, which are imported to 80C51SCM through 7483I/O panel. When 80C51 receives data orders sent by on-site industrial personal computers connected on the spot, the collected data will form data packages, and be uploaded to on-site industrial personal computers from RS-232 serial port. On-site industrial personal computers will then upload the data to the main monitoring computer through Wi-Fi. On-site IPC serves as the host computer, and 80C51SCM serves as the slave with baud rate set as 2400b/s; the format of the information frames is set with 1 start bit, 8 data bits, 1 the programmable bit and 1 stop bit; cumulative sum is adopted

in verification; and industrial personal computers adopt inquiry as the method of receiving and sending data, thus transmitting data, 80C51 sends and receives Data 2 through interrupt mode.

3.6. Sensor Warning

Sensors are a type of testing device capable of sensing the measured information and converting and exporting the received information to electric signals or information of other needed forms[11,12], so as to meet the needs of transmitting, processing, storing, displaying and recording information. Data of monitored changes in the software will be displayed in curves. The software has section analysis, displacement vector analysis, acceleration analysis, historical data query and hierarchical alarm systems. It can display the monitored structural chart and sensor layout. The storage module of the software is Oracle database, capable of storing a huge amount of data. In the extraction and production of oil fields, explosion-proof monitoring system is designed in the monitoring rooms of various sub-stations of the oil field prevention and control monitoring system through fibre technology, and received video signals are encoded through digital coders before being reduced to two channels of signal, one channel for real-time monitoring and collection and the other channel serves as backup data. Explosion-proof data for oil production sites are monitored[13,14].

4. Conclusions

This paper introduces the up-to-date IoT technology to the field of oil rigs through analyzing existing problems with oil wells, monitors oil rigs in real time to prevent safety hazards: on the one hand, factors of fires can be reduced, and on the other hand, timely warnings can be given when explosions and fire take place while effective measures can be adopted to control the deterioration of fires and guarantee the safety of workers and the well site. All in all, the research on the intelligent monitoring system of oil wells based on IoT lays a solid foundation for the development of oil wells, facilitate the promotion and application in reality, plays a positive part and bears significant value.

Acknowledgement

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