Design and implementation of rig remote monitoring system based on android mobile terminals

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Abstract

With the increasing coverage of wireless local area network and the rapid popularity of intelligent terminal equipments, this paper designs a system, in which oil rig can be remote monitored by any mobile devices to satisfy the processing needs of remote control function in the industry of oil and natural gas. The system contains the drill site end with the Force Control V8 programming, the database server and the mobile terminals with Android programming. The design and implementation of the monitoring system ,which carried on drilling test platform, make not only the driller but also the other key personnel can check the parameter of drilling field machines at any time, also technical personnel can shut down the equipment in emergency by mobile devices.

Keywords

Rig Remote Monitoring System; Androidterminal; Oil and Gas ; WLAN.

1. Introduction

Safe production has always been the most important process of oil and gas production. The drilling rig, as one of the most important part, is often used in the field of remote, communicable inconvenience, traffic difficulties and frequent relocation of the occasion [1]. This makes the relevant technical personnel cannot master the operation of drilling rig at the right time. Once the failure cannot be quickly processed, and then will lead to significant production safety accidents. At the same time, taking into account that China has transferred oil and gas exploration and exploitation of the main battlefield to the west, it needs to face so many problems: the diversification of the reservoir, buried depth, the complexity of geological conditions [2], which make development of an oil drilling rig remote monitoring system has become very urgent.

As early as the first Internet remote monitoring and diagnostic work conference held in January 1997, the idea of remote monitoring for the equipment has been proposed. Instruments National **C**ompany firstly added a network communication module in its Window/CVA Lab and View Lab, to deal with WWW, FTP, E-Mail and other ways to transfer the data [3]. The rise of the mobile phone network is making GPRS technology based on rig remote monitoring system widely used. It can complete the running state of the equipment information, collection and transmission through the mobile network operators, and greatly improve the reliability of oil drilling rig system and drilling automatic level [4,5]. Comprehensive coverage of wireless LAN technology has gradually replaced the mobile phone network, via Wi Fi, components of the ad hoc mode in the wireless sensor network, realized the derrick, mud pump, winch, turntable four equipment operating parameters real-time monitoring [6].

All kinds of terminal equipment, as the carrier of the mobile Internet era, have become a necessity of daily life. With the mature of wireless local area network technology, the information can be more efficiently transmitted. With the Launch of Google's Android system and its powerful functions and openness, not only the market share in currently intelligent terminal market is expanding, but also the

Android system has become a better choice of intelligent system related research project [7]. Meanwhile, Android platform supports the Java language programming, which has a very good versatility, high efficiency and cross platform to facilitate the completion of the project development [8].

Based on the background above, the author proposes a kind of drilling rig remote monitoring system based on Android mobile terminal. The system includes the field end drilling equipment, dual network card database server and client mobile device. Capable of operating parameters of the real-time acquisition from the sensors at winch, turntable, derrick and wellhead, through double interface server storage while waiting for the mobile terminal access. Once fault occurs, the personnel who is holding mobile devices of the key technical can make emergency shutdown operation. In the pursuit of a more friendly software programming UI interface, the server side is set to prevent malicious tampering with advanced permissions.

2. System design

2.1 On-site end design

On-site PLC **selects** the production of SIEMENS S7-200 as the control system core and PROFIBUS-DP network control program, programming language select STEP7-Micro/WIN. The programming language supports three kinds of programs that can be switched at any time: IL, LAD, FBD provide users with more convenient to monitor development environment. The selection of the Force Control V8 software for software programming is based on the Windows environment for the production of the field data collection, monitoring, processing and control of special software. The field monitoring module includes five parts: the winch system, the automatic drilling system, the turntable system, the derrick hoisting system and the simulation shaft. Each part of the module is equipped with Beijing West of CYB series sensor, for the running equipment`s parameters collection.

2.2 Server design

The server end is the bridge between the client side and the On-site end with dual network card. The port links to the end of the system using wireless local area network's configuration, the other port links to the Internet with a static IP address. Selection of the Microsoft Corp introduced the relational database management system SQL Server Microsoft 2012 storage data. The reason why choosing Server SQL is that it has high degree of integration of related software and good compatibility. In this system, the database receives the field equipment information from the site of Force Control V8 software and also can be remote accessed from the Android mobile phone client, so the SQL Server database is the best choice for this system.

2.3 Client design

Client end makes Android development platform for programming. As an open source mobile development platform that released by Google Inc., Android can let its users develop systems, UI and applications in an accessible way. Between server and client, there is TCP/IP protocol for communication. Using java language to write client interface, background program, register and login, each system equipment state display, alarm information query and emergency shut off. In May 2013 Google conference, the Google Corporation launched a new Android development environment Android Studio, and in May 2015 the Google conference launched its 1.3 version. As the Android Studio platform creatively put interface SDK and debugging tools AVD together to simplify the configuration of the Android development work, so the system client chooses Studio Android as a development tool.

2.4 Overall system design

This system uses C/S model and implements the design of server database and Android Application. The system working process is that drill start merits and sensors collect parameters, all the information are sent to the PLC, and with the help of remote communication module on the PLC, then the

information are transmitted to the server database. At the same time, the key personnel who has the Android device can setup APP and access server database to check the information; if there is an emergency accident, the key personnel can shut down the drilling rig directly. System working process and the overall design are as the pictures below.

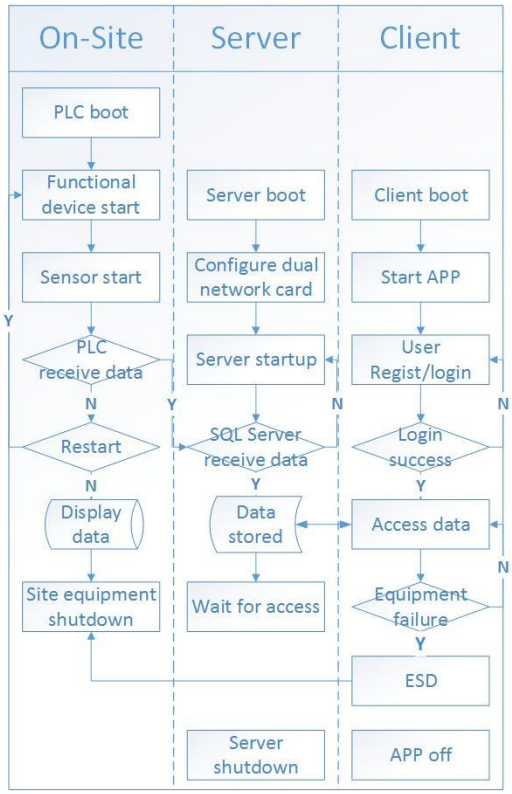

Figure 1 the flow chart of the System

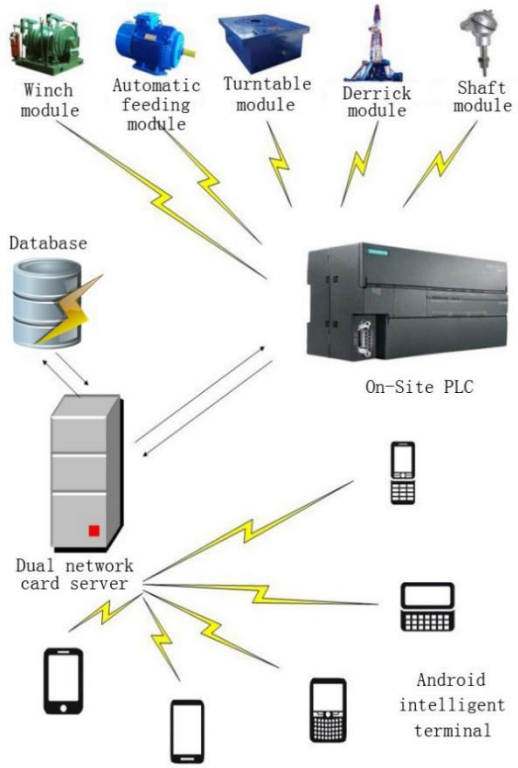

Figure 2 Integral design

3. System realization principle

3.1 Server configuration

After installing the dual network card on the server correctly, it can identify and configure the dual network card information through the Windows system. The card that connected to the On-site end is named as NWK and the card that connected to the Ethernet is named as WWK. Respectively, the card correspondingly configures static IP address, subnet mask and gateway. Considering the internal conflict of routing problem, the routing table of the system needs to be configured. In the CMD environment, the routing table can be respectively added in card through the route instructions and avoid conflicts caused by network instability, thereby affecting the incoming data equipment and accessing.

After completing the network configuration, it is required to install and create database tables on the server. Server SQL 2012 database adds a function on custom server permissions, which makes the use of the whole system in version has a substantial increase in security performance. In view of this system, it uses the SQL statement to create a database, and adds two data tables. Respectively, the tables are used to store the registered user information and field equipment information.

3.2 On-site PLC Configuration

The field end of all kinds of sensors collect and transmit to the PLC through the field bus PROFIBUS-DP, and then sent to the database by Force Control V8 software. It mainly introduce the field of I/O equipment adjustment and the field data transmission method.

Figure 3 On-site Sensors

At the front end of the whole system, the state information of the mechanical equipment of the drilling platform is collected by the sensor with I/O function. In order to exchange the data that achieved through the Force Control V8 software, it has to set the serial port firstly. Generally, the name of the device, physical address and communication are required in the settings dialog box in detail. The most important part of the operation is to transfer the device parameters to the server database in On-site end. As the Force Control V8 software comes with ODBC specifications, and it has been packaged ADO components, PC can transfer the collected data to the Server SQL database automatically.

3.3 Client configuration and data access

Android Studio gives customers a clear Android engineering structure and the Gradle management tools to create a client project in very convenient way. By creating the project and adding activities under the Java folder directly, it will be able to generate an activity file and an XML file. In order to enable the project to support to link the Server SQL, the Jar package also needs to join the relevant. For the operation of the database, programming with encapsulation method, a new Java file, driven by Class.forname (driver) method to load the database, then use getConnection() (URL, username, password) method to obtain database link. Operation database can use Statement (SQL) method directly to call the SQL statement.

It is worth noticing that, the database device table adds identify column for the fault in order to implement the alarm function. In the client app MainActivity interface, a method used to cycle to access database alert column, which can be used to find the alarm information timely, then with the Intent method to jump to the alarm interface AlertActivity and shows alarm information with alarm music. The technical personnel who holding mobile phones can hear alarm sound and choose to inform the driller to adjust operation, or emergency shutdown the equipment.

4. The Debugging and Analysis Results of the System

Firstly the implementation of database server is shown as follows: By checking the network adapter, the two ICONS of the Dual-Network Interface Card (NIC) can be found and renamed as “inner NIC” and “external NIC”. Secondly, set the Dual-NIC separately. The IP address of the inner NIC is 192.168.42.150, and the subnet mask is 255.255.255.0, and the gateway is 192.168.42.173. The IP

address of the external NIC is 192.168.1.1, subnet mask is 255.255.255.0, and the gateway is 192.168.1.1. Then open CMD window to configure the local PC routing table by entering the command "route delete 0.0.0.0" to remove route to 0.0.0.0, and add the network static routing "route -p add 192.168.42.0 mask 255.255.255.0 192.168.42.150".

Open the SQL Server2012 of the server, and use SQL commands to create the database My Project. Two tables are built: one is "userinfo" and the other is "workdata". the former is used for the registry to storage including ID primary key, user name, password, email and telephone, and the latter is used for data storage from PLC including ID primary key, the transmission data from various kinds of sensors, which is also adding the INT type alarm and judgment columns and SMALLDATETIME type time columns. The 0/1 value of the alarm columns which is utilized to judge the alarm information, and the 0 value means that the field equipments operate well, the 1 value indicates that the field equipments break down. The time columns corresponding with them can easily find a record which has malfunction.

结果 消息

	id	username	password	email	phone
1	1	hu	12345	12345@qq.com	88377439
2	2	an	23456	345234@qq.com	56554811
3	3	jie	75345	9393845@126.com	55432432
4	4	xiong	wsad222	523442@gmail.com	3306

结果 消息

	JCmove(cm)	ZPtorque(N*m)	SZpull(N)	JJmove1(cm)	JJmove2(cm)	JTpres(Mpa)	JTtemp(℃)	Time	Alert
1	0.42	16	2703	0.19	0.19	6.7	44	2015-07-07 12:44:07.000	0
2	0.44	17	2729	0.24	0.24	6.73	44	2015-07-07 12:44:12.000	0
3	0.45	17	2727	0.3	0.3	6.77	45	2015-07-07 12:44:17.000	0
4	0.46	17	2730	0.36	0.36	6.82	45	2015-07-07 12:44:22.000	0

Figure 4 The query results table of the Database

Field data are sent to the server through PLC by the utilization of the Control Force V6.1. Firstly build the new data source through ODBCRouter components in the software, then select the remote connection, and the connection database IP address has been configured in the server settings. Secondly, build the assignment and select "Microsoft OLE DB provider for SQL Server" to configure the database login user name and password. Then set up the database acquisition trigger type as cycle trig, and the time interval is set to 1 second. Finally click the finish button and meanwhile run the system.

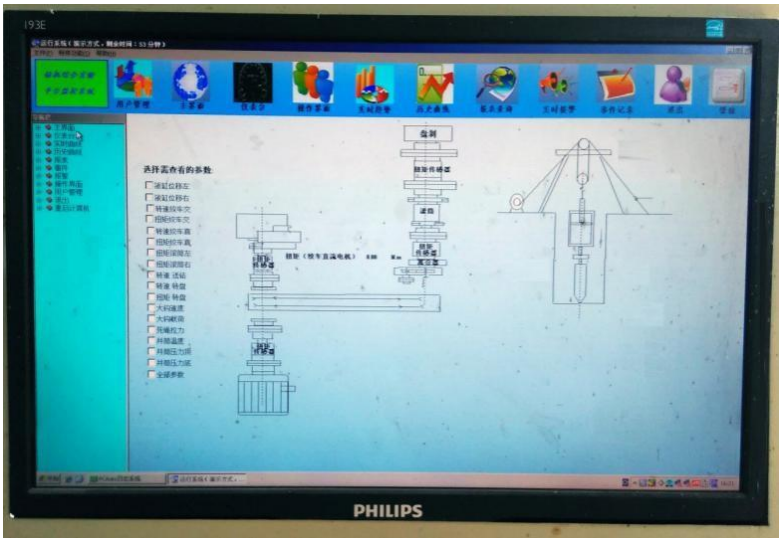

Figure 5 The interface diagram of the field

Client can access server through the App developed by the Android Studio platform. Firstly, put the layout of the page into practise and manipulate the .XML file. The Linear layout and Table layout are combined with each other, and registration/login screen, main interface, each function module information query interface and independent alarm interface are created respectively, at the same time, some beautification and humanized modification are done. Next operate the database: copy the download supporting SQL Server2012 Jar package to the .Libs folder in the project, and join the project directory; find out the AndroidManifest.xml file in the project, and add the code <uses-permission android: name = "android. Permission INTERNET"> to add the network function; build the JdbcUtils.java file in the java folder and encapsulate database operation instructions. From JdbcUtils.java, call the Class.forname(), getConnection(), Statement() in turn, and realise the function of the field device data searching and the database table modification after alarming.

Figure 6 function interface diagram of the Client

Set an “Intent” in the main interface used as an alarm. By calling the search function in the JdbcUtils.java file, it will traversal search the alarm field in the workdata table, and the query SQL statement is: SELECT *workdata FROM where ALT=1. If the return value is null, then initialize the watching condition; However, If the return value is “true” of the “Boolean” type, then start up the “Intent” and switch into independent alarm interface to alarm by calling the MediaPlay().

After the completion of equipment installation and programming, it should be operated in the field. Finally, data can be collected from various sensors in the field, in addition, it can be captured through the field bus by PLC which controlled by the V6.1 software. Through the LAN, the data can transmit to the remote SQL Server2012 database. All the connected Android users who have the right to install the App can register and log in the system via Ethernet and access server database through the touch screen of the phone. In addition, the users can acquire the real-time running status information of the field equipment and shut off especially in the situation of the alarming.

5. Conclusion

Each upgrade of the oil drilling rig is accompanied by the generation of new technology. This time, the mobile Internet technology combined with the oil rig site monitoring, resulting in a rig remote monitoring system based on Android mobile terminal. the key technical personnel can view site working condition of equipment at anytime, anywhere via the Android mobile device, emergency shutdown function can also remote control the drilling to make sure drill can complete drilling tasks efficiently and safely. After the test in oil drilling test bench, it obtains good effect. At the same time, the system has good portability and extension from both the software and hardware, and can be used in most of the drilling rig site after the adaptability adjustment.

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