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The research of medical equipment on-line detection system based on Android smartphone

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Abstract. With the unceasing enhancement of medical level, the expanding scale of medical institutions, medical equipment as an important tool for disease diagnosis, treatment and prevention, used in all levels of medical institutions. The quality and accuracy of the Medical equipment play a key role in the doctor's diagnosis and treatment effect, medical metrology as the important technical foundation is to ensure that the equipment, technology, material components are accurate and the application is safe and reliable. Medical equipment have the feature of variety, large quantity, long using cycle, expensive and multi-site, which bring great difficulty in maintenance, equipment management and verification. Therefore, how to get the medical measurement integrate deeply into the advanced internet technology, information technology and the new measuring method, for real-time monitoring of medical equipment, tracking, positioning, and query is particularly important.

1. The present situation and tendency of the development of medical metrology

Medical metrology research measuring characteristic parameters of the medical instruments whether meet the relevant technical regulations or regulations, to ensure the reliability of medical value. [1] Metrology standards, technical conditions, personnel qualification, evaluation method and etc involved in the medical metrology are confirmed in the form of technical regulations. Measuring instruments and equipments used in medical and health will be listed in the national compulsory verification directory in our country (a total of 60 items and 117 kinds, 40 items and 76 kinds used in medical and health care, about 66%). Legal institutions implement in the form of mandatory verification, any units and individual must not refuse the supervision and inspection, therefore, medical metrology in our country has the legal characteristics [2].

According to the projects of medical metrological verification that our country has carried out and the main testing index, medical metrological can be divided into the following categories:

(1) Medical radiation instrument (X-ray machine, CT, ECT, Accelerator, DSA, etc).
(2) Medical electrophysiological instrument (Electrocardiograph, Electroencephalograph, Multi-parameter monitor, High-frequency electric knife, Cardiac defibrillators, etc).
(3) Medical biomechanics and thermal instrument (Thermometer, Blood pressure, oxygen gauge, pressure gauge, Breathing machine, Anesthesia machine, Infusion pumps, Scales, Flowmeter, Centrifuges, etc).
(4) Medical biochemistry instrument (Blood cell analyzer, acidity meter, blood gas analyzer, oxygen filling degree of instrument, biochemical analyzer, urine analyzer, etc).
(5) Medical optical instruments (Spectrophotometer, Ophthalmic optics, ELISA analyzer, etc).
(6) Medical laser instrument (Laser surgery and treatment equipment, Medical laser source, etc).
(7) Medical ultrasonic instrument (Ultrasonic diagnostic instrument, Ultrasonic source of ultrasonic doppler fetal monitor, etc).
(8) Medical acoustic measurement (Sound intensity meter, Audiometer, etc).

Existing medical measurement system is based on the professional disciplines such as length (geometrical quantity), mechanics, optics, electromagnetics, radio, ionizing radiation and medicine, time frequency, acoustic, etc, which is established on the basis of single parameter dissemination, with the development of high-tech and the wide application of computer in medical equipment, medical equipment is on the direction for development of intelligent, digital, multi-function, multi-parameter, the existing system of medical metrology already cannot satisfy the needs of the development of modern medical metrology.

According to the regulation of metrological verification procedures in our country, we generally implement cycle metrological verification to the standard measuring instruments and the work measuring instruments, this is made under certain conditions on the basis of the universal laws of measuring instruments incorrectness. With the emergence of large, sophisticated and expensive medical equipment (such as CT, MRI, PET, etc) and the special needs of medical institutions, generally in the running for a long time, breathing machine, monitoring equipment, work for days or months or even longer. If equipment used in process get failure or downtime, may cause medical accidents and even death. In the aspect of metrological verification, the traditional detection method, in addition to regular on-site detection, but also writing paper test records, affect the detection efficiency, in the industrial field, real-time on-line monitoring, data remote transmission and the management information system based on database technology developed quickly, effectively guarantee the efficiency and safety of the equipment. Therefore, medical equipment on-line detection technique based on internet will be widely used and developed in the field of medical metrology.

2. The overall conception of on-line detection system

This system based on combination of computer technology, wireless communication technology, medical instrument detection technology and embedded technology, using the intelligent mobile as terminal equipment formed wireless monitoring network with the laboratory monitoring center based on 4G, intelligent mobile phone and detecting equipment formed a wireless communication network, which complete the data transmission of various test results, laboratory monitoring center complete interaction of information with users and storage of data using the WEB technology and database technology [3].

The online detection system is mainly composed of detecting equipment, smartphones, monitoring central server, and WEB terminals [4]. Metrological verifiers check instrument in accordance with state regulations, enter the original data into the intelligent mobile terminal in real time, intelligent mobile terminal sent the data to the laboratory monitoring central server through simply data processing, analysis, storage and so on, provide basic data for laboratory personnel to analyze and calculate, then generate electronic records and verification certificate automatically [5]. Provide data storage access support for the system using background database, establish instrument archives, WEB terminal mainly provide all kinds of information query, including autoreminders of periodical verification.

3 The overall design and architecture of system

3.1 Main function of system

Metrological verifiers enter calibration parameters of the checked instrument into intelligent mobile terminal in real-time.

The intelligent mobile terminal identify basic information of the instrument by scanning the QR code on it, including model, serial number and manufacturer, store the detecting data and simply analyze [6].

Mobile terminal surf the internet using 4G, and communicate with the central server, receiving various instructions of central server, and upload the testing data of instrument.

The central server provides data processing, storage, query, real-time monitoring, equipment files and the automatic generation of test record and printing, generates verification certificate automatically.

User can track the testing status of instrument through WEB, receive reminds of the test cycle.

3.2 The overall architecture of the online detection system

The online detection system is mainly composed of detecting equipment, smartphones, monitoring central server and WEB terminal, the block diagram of system composition is shown in Figure1:

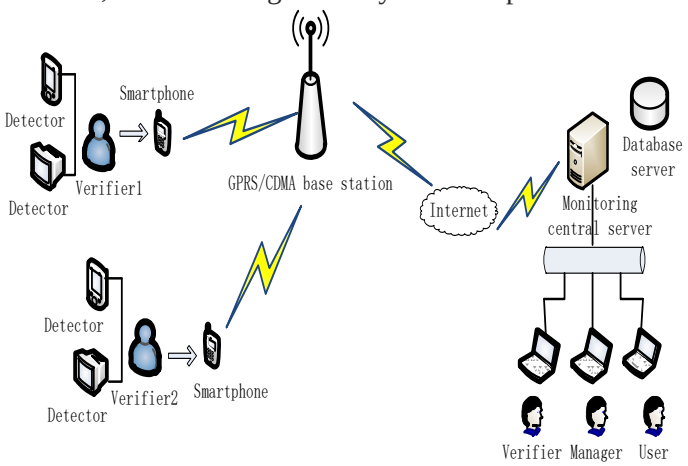

Figure1. Medical equipment on-line detection system overall structure

Metrological verifiers enter the detecting data into smartphone, provide the raw data for the online detection system, smartphone complete data transmission with the central server, realize the system function according to the communication protocol of application layer.

Monitoring center is the core of this system, the management center of system network, data processing center. Manages all network connection of online remote mobile terminal, receive all kinds of data packets send back from the network and parse according to the communication protocol, get all the test parameters of the instrument checked in the system, the monitoring center provide full record, storage for all the different kinds of data return from terminal equipment and generate the test records and certificates. Metrological verifiers can review and query the result of the test data, monitoring center contains database server and content management server.

Communication network connects the two parts above-mentioned

GPRS communication connects intelligent mobile terminal and monitoring central server.

3.3 Software structure of the system

Communication subsystem builds a communication bridge between field testing and laboratory, its communication with the laboratory central server using the existing mature mobile network, connect with central server of the laboratory via smartphone, transmit detecting parameters to the monitoring central server in laboratory in real-time, forming a remote monitoring network.

Besides, intelligent mobile terminal in the communication subsystem have certain ability of data analysis, can simply analyze the status of instrument according to the testing parameters, case is unqualified, can provide sound and light alarm.

Communication subsystem consists of the following modules: SOCKET communication, data encapsulation, data processing, data storage, display unit, alarm module, etc. The component diagram is shown in Figure 2:

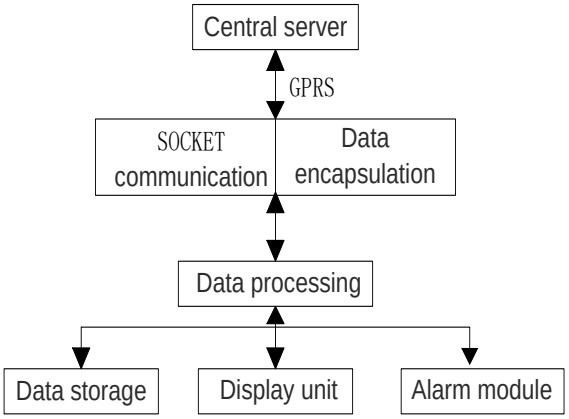

Figure 2. Configuration diagram of communication subsystem

SOCKET communication: The central server communicates with intelligent mobile terminal based on TCP/IP protocol, this module program using SOCKET, send and receive data.

Data encapsulation: Encapsulate all kinds of test parameters according to format of communication data.

Data processing: Processing various commands from central server, processing various testing parameters return from the mobile terminal.

Data storage: Store all kinds of information of the instrument, including parameters of basic information and detection, etc.

Display unit: Display of various test parameters and the instructions of verifiers, etc. Alarm module: Intelligent mobile terminal can simply analyze parameters of the instrument, if the case is unqualified, send out sound and light alarm via smartphone.

Central server is located in the laboratory of testing institutions, which constitutes a LAN system on the hardware, connects internet through the firewall, receives all the data information from mobile terminals on the network. Monitoring central server includes application server, database server and multiple operating terminals. Monitoring central server achieves monitoring in real-time of the remote terminals, data archiving and files management of instruments, etc. The central server consists of the following modules: SOCKET communication, data encapsulation, data processing, data storage, the user terminal, auxiliary diagnosis, data management, database server, WEB server module, etc. Its composition is shown in Figure 3:

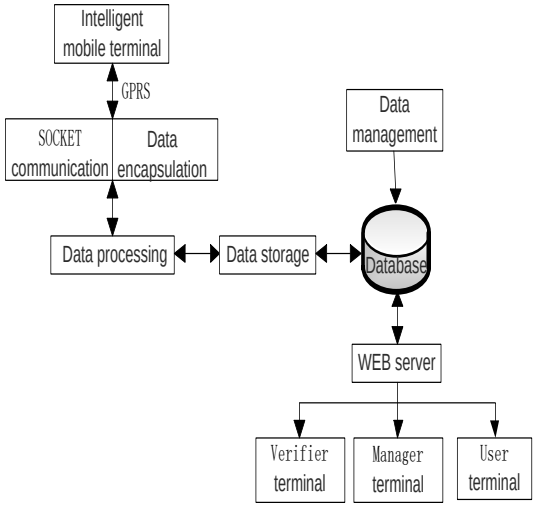

Figure 3. Configuration diagram of central server subsystem

SOCKET communication: The central server communicates with intelligent mobile terminal based on TCP/IP protocol, this module program using SOCKET, send and receive data. Data encapsulation: Encapsulate all kinds of test parameters according to format of communication data. Data processing: Processing all kinds of test parameters, query commands of verifiers, control instructions, etc. Data storage: Store testing parameters of instrument, equipment files, generate test record and certificate. User terminal: Provide parameters query, monitoring instruments, and receive various control instructions from verifiers. Data management: Management of database, WEB server, equipment archives and other various data to add, delete, modify;

Database server: The core data storage of the whole system, establish a database with perfect data storage relationship. WEB server: Provide all sorts of information query for verifiers, managers and users.

3.4 System process

Intelligent mobile terminal can work in three different modes, active query, instrument testing and real-time upload. The operation mode of the smartphone is chosen by verifiers according to the work requirements. The mode of active query, smartphone keep network connecting status with the central server, verifiers scan the QR code on the instrument using smartphones to identify the basic information about it, including serial number, model and manufacturer. And then into the mode of instrument testing, verifiers enter the testing data into smartphone terminal according to the procedure set internally. Real-time upload, intelligent mobile terminal connect to the monitoring central server in laboratory after receiving the data collected by the results, and then sent testing parameters to the central server, meanwhile receive all kinds of instructions of it. After a period of time, without change of work mode or other instructions, smartphone disconnected from the network, waiting for the next data acquisition and upload.

Central server sends various query commands of testing parameters to intelligent mobile terminal all times according to the requirements of verifiers (including historical data), smartphone executes the query command after received, then sents back the query result to the central server, waiting to be processed by the verifiers, if not receive any orders, smartphone get into standby. Central server archives the data from smartphone, automatically generate electronic records and certificates, users can undertake all kinds of information query through a WEB.

3.5 The main technical characteristics

This system constitutes a remote wireless communication network using GPRS technology, monitoring center in laboratory builds a long distance communication network with the intelligent terminal using GPRS, on the basis of which send and receive data using the TCP/IP protocol, completed the communication of data between monitoring center and the intelligent terminal. Monitoring center which is the core of the system, is also the data integration and processing center of the system, in this system all the testing data of instruments will be transferred to here, monitoring center provides full records, full storage, generates electronic records and certificates, designed remind of verification cycle for each user, can handle testing data of multiple instruments at the same time. Intelligent terminal realized the acquisition of detection data, front-end analysis and processing, data communications, and other functions.

4. The conclusion

Successful application of online detection technology in the field of industry can really guarantee the efficiency and safety of the equipment effectively, however medical equipment is mainly used for parameters testing in the human body, which is different from the traditional parameters detection of length, thermal, mechanics and electricity, so there is a big difficulty in the achievement of online detection in real-time and remote monitoring, this need instrument manufacturers design a remote communication module for each instrument, and support remote data transmission, still need develop detecting equipment for each corresponding instrument according to the verification regulation of it, which combine with a variety of communication protocol to complete the design and development of

online detection system. This article developed a remote data transmission device based on the android smartphone, which implement the data processing, real-time transmission, storage and information management system, provide a network architecture for the medical equipment on-line detection, can also improve the efficiency of detection greatly at this stage.

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