Design and Implementation of Intelligent Measurement Testing and Calibration Management Information System based on Big Data

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Abstract. In recent years, most testing and calibration laboratories in developed and developing countries have generally enhanced the awareness of information construction by adopting laboratory information management systems to strengthen the information construction. This paper designs an intelligent measurement testing and calibration management information system based on large data, aiming at the problems of data connection and transfer, sample flow management, weak quality management and customer's informed inspection status in testing and calibration laboratory. The system adopts B/S and C/S mixed development mode, uses the current popular information technologies and utilizes reasonably SQL Server database resources. Based on the network topology and architecture of the system, the system realizes function modules. In addition, this paper makes innovations in measurement equipment, sample testing, operation record, certificate life cycle management, multi-channel notification to customers, intelligent early warning. Therefore, the intelligent measurement and calibration management information system provides guarantee for improving refined management level of measuring and testing Institutes and third-party detection institutions, standardizing business processes, improving work efficiency and quality management, and providing better service to customers.

1. Introduction

With the continuous development of information technologies (big data, cloud computing and blockchain), abundant mass data, which provides the basis and power for the origin of intelligent measurement and detection, is generated from the information of measurement equipment, verification and calibration, customer information, process information and original record information. Developed and developing countries have generally enhanced the awareness of information construction of metrological testing laboratories[1]. They believe that the laboratory information management system is the key component of the whole enterprise information system[2]. The International Organization for Standardization in 2017 issued the General Requirements for Laboratory Management System Testing and Calibrating Laboratory Capabilities, and this document clearly explained the management and security of data in the laboratory information management system[3].

At present, most testing and calibration laboratories adopt the laboratory information management system to manage the testing and calibration business[4], and develop toward the direction of refined management[5]. However, there are a lot of weak links in connection and call of data such as electronic original record, sample flow management, quality management and so on. Through the research and development of intelligent measurement testing and calibration management information system, it
can improve the management level and work efficiency of metrology testing institutions and third-party testing institutions, and also ensure scientific and accurate testing and calibration certificates in order to get the approval of different provinces, cities, regions and countries.

2. System Requirement Analysis
The laboratory information management system for testing and calibration belongs to a kind of application software for storing and managing information acquired in the course of laboratory work. It is used to control and manage samples, standards, test results, reports, laboratory personnel, workflow automation and instruments [6]. At present, most testing and calibration laboratories adopt laboratory information management system to manage the testing and calibration business. Based on large data Intelligent measurement testing and calibration management information system is a multi-level management network management system, which is suitable for the testing and calibration laboratories of metrology institutes and third-party testing institutions. The aim of developing intelligent measurement testing and calibration management information system is to solve the problems of measurement detection, inefficiency of calibration process and large data, sample flow and weak quality management. Therefore, the main requirements of intelligent metrology detection and calibration management information system are as follows:

(1) Orient to multi-user operation: Intelligent measurement management information system has many users, including leadership, management, business, laboratory operation, etc. It needs to be oriented to multi-user, so it needs to set different operation rights according to the user's responsibilities.

(2) Realize the management of big measurement data: big measurement data includes equipment information sent by customers, process data of measurement and testing, electronic original record of certificate making and information of testing equipment. On the basis of realizing the big data of measurement, the data connection and transfer of the big data of measurement is realized at the same time.

(3) Sample flow management: Sample management is the basis to ensure the smooth progress and completion of the verification and calibration process. The realization of sample flow management can not only satisfy customers'timely attention to the progress of testing samples, but also ensure the efficiency of laboratory testing.

(4) Improve the quality management of testing or calibration laboratories: Because there is a big gap between laboratory management and expected results, managers focus on the daily management of laboratories, standardized management, rigorous testing process, and usually focus on the rigorous and standardized management of specific testing process, lacking the operation of quality management system. Concern about the situation.

3. System Overall Design

3.1 Network Topology
According to the requirement analysis of this paper, an intelligent measurement and calibration management information system is designed. The topographic diagram of management information systems is shown in Figure 1.

Customers or users of certification organizations use mobile APP, Wechat Public Number, remote office and mobile office to access the Internet. Customer hosting service provides software application service for the Internet. Public service platform provides public service consulting service, appointment and inspection service in DMZ (Demilitarized Zone), and other services for sending and inspecting customers. Users provide secure business progress queries, certificate authenticity queries, certificate self-printing services; data and core business application servers, behind the firewall, provide the most secure data protection, avoid malicious or unintentional attacks from outside and inside, and isolate the possible spread of viruses to ensure the security of institutional data; branches of
detection agencies Branches of institutions or third-party verification agencies access the system through secure digital links.

![Network Topology](image)

**Figure 1 Network Topology**

### 3.2 System Architecture Diagram

Intelligent measurement testing and calibration management information system is developed in the mixed mode of B/S and C/S. C/S development is used for interface service development; the system architecture of B/S includes display layer, function module, infrastructure, underlying platform and system security management as shown in Figure 2.

1. **Presentation layer**: Because presentation layer provides visual and friendly operation interface, so it can provides good interface effect for user operation, reduces user operation as much as possible in the design process, and improves the automation level of system operation.

2. **Function modules**: Intelligent measurement testing and calibration management information system is composed of safety management module, basic data maintenance module, measurement service module, sample flow management module, electronic original record management module and quality management module.

3. **Infrastructure**: The system is based on the framework platform of .NET Framework and the database is accessed by using Angular 2 and other components.

4. **The underlying platform**: The system uses SQL SERVER 2014 database, Microsoft IIS server, and so on, to complete the underlying architecture.

5. **System security management**: Based on the security awareness of enterprises at home and abroad, information system achieves system management, role management, user authentication, authority management and data backup functions in the security management module.
4. Design and Implementation of Function Module of System

4.1 Basic Data Maintenance Module
The basic data maintenance module mainly provides maintenance for the basic data necessary for the operation of the system, such as price standards, customer information, measurement standards, verification equipment, rules and standards, personnel qualifications, etc. The basic data maintenance platform adds, deletes, modifies and queries standard charges, customer information, measurement standards, verification equipment, rules and standards, personnel qualifications, etc.

4.2 Measurement Business Management Module
The measurement business management module involves the acceptance of verification, calibration, testing and other business, the arrangement of inspection tasks, sample circulation, sample storage, cost determination, cost modification, abnormal process processing, certificate production, certificate report centralized printing, completion registration, fee notification, fee registration and other functional modules. The system realizes the standardized management of the core process of measurement business. Measurement business management is a window for metrology verification agencies to deal with customers directly. It is also a carrier to reflect the level of business management, process standardization, work efficiency and work ability of metrology institutions.

4.3 Sample Flow Management Module
Sample flow management module is the basis to ensure the smooth progress and completion of the detection and calibration process. For the management of sample flow, special means are needed, such as marking samples by barcode and two-dimensional code, tracking and locating the location of samples throughout the whole process, and managing the warehousing, storage and discharge of the sample library. Sample flow management uses the Internet of Things technology and the means of sample tracking, and it ultimately avoids all kinds of disputes caused by the custody of samples with customers.

4.4 Electronic Original Record Management Module
The management module of electronic original record is the management of process information and electronic original record of intelligent measurement testing and calibration management information system. Among them, the electronic original record of verification or calibration certificate directly records the test data in picture format and PDF format, replacing the traditional paper record system to ensure the accuracy and reliability of the certificate. The inspector scans and uploads the test data. The action eliminates the "paper-computer" input process, reduces duplication of work and avoids input errors caused by report editing.

4.5 Quality Management Module
Quality management module mainly refers to the daily work information of quality department, personnel department and professional department (such as rules and standards, standard instrument, standard material, personnel maintenance, certificate issuance, original record management, etc.). This module reduces workload and error rate by means of information technology, and manages all processes and experimental data. On this basis, only the corresponding data in the basic database of the system can be invoked to avoid input errors easily caused by manual input.

The main processes of quality management module include:
(1) Standardized management process: all related activities such as equipment procurement, accounting, value trace ability, outage and scrap are included in the scope of information management.
(2) Regulations regulate the management process: it involves procedures update, input, upload, query and download, and controlled operations.
(3) Certificate audit and approval process: the process includes the production of original record template, audit and approval, controlled, certificate selection, data entry, certificate printing.
(4) Personnel qualification management: management includes qualification of verification personnel, authorized verification personnel, authorized signatory's qualification and authorized scope, etc.

(5) Quality management process: It covers daily quality management process, period check, certificate spot check, personnel supervision, quality control of test results, etc.

5. Innovative application
Combining with the literature of previous scholars, the design of intelligent measurement testing and calibration management information system not only takes into account the basic needs, but also makes innovations in life cycle management, customer's multi-channel notification and intelligent early warning.

(1) Life Cycle Management
Life cycle management (LCM) is a whole cycle of information and process for the generation, operation, use, modification, deletion or recovery of things. The whole life cycle management of intelligent measurement and calibration management information system includes the whole life cycle management of measurement equipment, sample detection, operation record, verification or calibration certificate.

The whole cycle management of measuring equipment refers to the whole life cycle management of the purchase of measuring and testing equipment, the inspection record and certificate maintenance of measuring and testing equipment, the maintenance of measuring equipment and the abandonment of measuring equipment.

The life cycle management of sample detection includes the life cycle management of sample delivery, sample detection and sample extraction.

Operation record life cycle management means that every step of operation of intelligent measurement and detection management information system will leave traces. System operators can check the operation according to their needs.

(2) Multi-channel notification
In order to facilitate customers to know about samples and certificates, in the process of sample verification or calibration, the information system pushes the information to a customer through various ways. The system notifies customers by means of email notification, short message notification, wechat notification and enterprise client notification.

(3) Intelligent Early Warning
Intelligent early warning is a function of information system to remind operators of their incomplete work. Operator obtains information of his unfinished work according to the user's rights to ensure the completion of the work. Intelligent early warning includes equipment cycle detection and early warning, equipment overdue early warning, standard warning, personnel qualification early warning, contract validity early warning and so on.

6. Summary
Developed and developing countries at home and abroad adopt the laboratory information management system of testing and calibration to strengthen the information construction, and the management of testing and calibration laboratories is developing towards the direction of fine management. Intelligent measurement testing and calibration management information system adopts B/S and C/S mixed mode development mode, using the current popular information technology such as Angular 2, Bootstrap, and rational use of SQL Server database resources. Based on the problems of data connection and transfer, sample flow management, weak quality management and customer's information about inspection status, this paper presents the network topology and architecture of the system.

Intelligent measurement and calibration management information system innovates in measurement equipment, sample detection, operation record, certificate life cycle management, multi-channel notification to customers and intelligent early warning. It provides guarantee for improving
refined management level, standardizing business processes, improving work efficiency, continuously improving quality management and better serving customers.

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