

Distributed Sampling Inspection Technology and Application

Chao-qun WEN\textsuperscript{1,2}, Gang WU\textsuperscript{1,2}, Fan ZHANG\textsuperscript{2},
Chao ZHAO\textsuperscript{2} and Hai-tao WANG\textsuperscript{2,*}

\textsuperscript{1}School of Software Engineering, Beijing Jiaotong University, Beijing, China
\textsuperscript{2}China National Institute of Standardization, Beijing, China

*Corresponding author

Keywords: Distributed random sampling, Lot-by-lot inspection, Real-time analysis.

Abstract. Sampling inspection is very important for quality control in enterprises. However, in the sampling inspection process, there are some difficult problems, such as large amount of products to inspect, the feedback of inspection result being not timely, the supervision and warning being inefficiently, and so on. This project proposes a distributed sampling inspection technology, and develops an application platform. According to the test results, the performance is approving.

Introduction

Sampling inspection is a statistical method which proves the satisfaction of the quality about certain product by selecting some of individuals from continuous lots. Enterprises also want to find what cause defects, how to improve them, and what those causes imply for product lines.

In the real sampling inspection processes, the workers sample and formulate program according to the quality requirements. Sampling procedures are very important for enterprises, because less sample size will cause more risks of wrong judgments, whereas, more sample size will cause more costs. Therefore, sampling for lot-by-lot inspection indexed by acceptance quality limit(AQL) is one of the most important methods for inspection by attributes [1]. This sampling schema is very precise theoretically, but very complex and difficult for real operations. Firstly, many factors and parameters must be determined and calculated, such as AQL, inspection level (IL), switching score, acceptance score, etc. Secondly, inspection procedures are usually distributed and parallelized. Inspection results from different workers must be collected and counted scores together to determine next step. Finally, all the results should be analyzed as soon as possible for the sake of quality control and supervision of products. A data center is demanded to which every inspect result should be sent. Furthermore, proper data analysis functions are required to figure out the change of quality. Many enterprises are equipped with many high-technology devices to improve the efficiency of sampling inspection, but reality is always cruel. One equipment is only used to a certain stage for testing and analyzing, so that the data of each part can’t be analyzed collectively and timely.

We developed a distributed sampling technology for lot-by-lot inspection, and implement a platform.

This platform can transmit sampling tasks and results through network; the sever can real-timely monitor the clients; and it can real-timely analysis the sampling results, help companies create a good quality control mechanism.

This paper is organized as follows. In the second section, we present the program of the sampling inspection technology based on distributed. In the third section, we present the relevant technology and system architecture. In fourth section, we present the experiment results by using the actual and show the overall process.

Sampling Inspection Technology Designation

In the sampling work of enterprises, workers often be distributed to different places for testing, we use lightweight server framework and the simplification of client applications, and the client be
real-time monitored, distributed collaboratively client may automatic judge on the sampling results, and analyze the sampling results real-timely, improve the efficiency of sampling inspection.

**Dynamic Load Balancing**

According to the standard of Sampling procedures for inspection by attributea-Part1: Sampling schemes indexed by acceptance quality limit(AQL) for lot-by-lot inspection, the staff create the sampling program based on the product batches, AQL, IL, stringency, transfer rules and other elements. It is possible that the same product of different batch has different sampling program. This situation result in staff need to spend a lot of time to design the sampling plan for each batch of product. And when the sample size is too large, due to the testing efficiency of staff is different, it will extend the overall sampling time. However, the platform can automatically design and create a sampling program, the staff just need to follow the system prompts to enter the AQL, IL, stringency, and other parameters. And the platform can update sampling program according to the sampling results. while in the inspection process, the platform achieves the client's dynamic load balancing according to the implementation and execution speed of sampling tasks, so we can dynamically adjust the task allocation, and make work efficiently.

**Automatic Inspection**

The Core of sampling work is selection and testing. In the actual inspection process, the staff measure sample, then judge the eligibility of the sample. There are often have some human negligence, and this is not conducive to the overall sample analysis of the results. To address this issue, we have simplified the client's operational processes, and the client only complete specimen sample data collection, use the automatic test function in the platform to ensure the integrity of the sample data, and reduced complexity.

**Real-Time Analysis**

The Work of sampling inspection can use the results of the product quality to predict the problem in production line and help improve manufacturing processes. However, in practice, the reports of the sampling inspection cannot generate real-timely, and some companies even have to wait a long time to complete the chart analysis of the test results. So the reports is merely a qualified file to companies, cannot play a role in the process of trim production line and help leader to making decision. We hope to change this situation, our clients can use network submit results and real-time analysis based on the implementation of sampling task. And we hope to found the rules and the quality trends of the production process through compare and analyze the historical data, help managers make decisions, improve the chances of qualified products and reduce the risk of product failure.

**System Architecture**

The platform uses a lightweight framework Spring + Hibernate to complete the development of Web applications, combined with distributed clients, including the sampling plan create and update, monitor clients real-timely, analyze sampling results real-timely and other features. And has good scalability and embeddability, the platform can be particular customization, and also work together with the company’s existing platform.

**The Overall Framework of the Platform**

The sampling inspection is directly work on the production lines, or dispersed the task to various parts of the plant, this way will consume a lot of time in distributing tasks and submitting results, and is not conducive to collect and analyze the data. We use the mode which has server and a number of clients, and they use network connect each other. The sampling process will be divided two stages that data collection and data analysis. The Server is responsible for creating and updating the sampling plan, monitoring clients, distributing tasks dynamically and analyzing the sampling results combined with historical data. The Client is responsible for completing the input of sample inspected results. This mode can reduce working stress, and improve working efficiency.
The overall framework of the platform as shown:

![Diagram of the overall framework of the platform.](image1)

**The Architecture of Sever**

The server is divided into four layers that data storage layer, processing layer, presentation layer and user layer. Using lightweight framework Spring and the persistence framework Hibernate, and ensure the overall low coupling and scalability. The Data storage layer is responsible for storing data, access and deal the database. The processing layer is responsible for processing data through Hibernate, including inspection, dynamic analyze tasks dynamically, judge results automatically, analyze results real-timely and other functional modules. The presentation layer is including system management, product management, client management, monitor sampling tasks and other function modules. The User layer, mainly through JavaScript, JSP, Ajax, JQuery and other technologies to provide simplify operations, improve operability, reduce complexity.

The architecture of sever as shown:

![Diagram of the architecture of sever.](image2)
The Flow Diagram of Client

In order to improve the work efficiency, reduce the work complexity, and improve the accuracy of monitoring the quality, we put the client as a tool for collect sample results. And the server will finish the work of judge qualified and analyze the results. We think the way will ensure the objectivity of data collection, analyze results real-timely and improve the accuracy of quality.

The flow diagram of client as shown:

![Flow Diagram of Client](image)

Figure 3. The flow diagram of client.

Experiments

First, we present an example to simulate the processes of sampling inspection in enterprise. Then, we present experimental results for real data compare historical sampling results for show that the quality of different batch.

Sampling Management

Sampling management, including product management, quality management, sampling plan management, sampling programs management and client management. The staff need input parameters depending on the different product in product management and quality management, then select the relevant request parameter in sampling plan management, and you will complete the create of the sampling plan. The server will automatically assign tasks according to client usage and dynamic load balancing. Upon the sampling results, the server will automatically judge quality and update the inspection sampling plans.
On the Web, staff can see the implementation of each client, monitor the client real-time, take advantage of the distributed clients.

The client can facilitate the staff collect sample results, has simple UI. The staff can see the information of need to check the quality characteristics of the sample, serial number, sample size and other information. The staff only need to input the measurement results, the server can finish judge and analyze for the results. The client simplify workflow and lower the standard of staff, help to improve work efficiency.

The Analysis of Sampling Results

Distributed client applications can improve working efficiency, improve the transfer rate of the sampling results, and quickly analyze the eligibility of these products through analyze the results real-timely. And get the next batch of product related parameters by look-up table, complete updating the next batch of product sampling program.

On the Web, we can make various analysis based on the sampling results and compare with historical data, and dynamically generate charts for show the analysis results by flowchart and etc., so that the staff can be more intuitive understanding of the situation of the quality of the product, and export the required charts. Due to space reasons, we only show a flowchart.
Summary

This paper summarized some lacks from the exists of sampling inspection process in enterprise, put forward a sampling inspection technology based on distributed. Implements the client distributed management and dynamic load balance. Automated inspection and real-time analysis will simplify workflow and reduce the difficulty of the work, improve working efficiency, provide a good solution for the enterprise to monitor product quality and early warning.

Acknowledgement

This paper is supported by grants from Ministry of Science and Technology of the People’s Republic of China (2016YFF0204205) and China National Institute of Standardization (522016Y-4681, 522016Y-4486, 2015QK241, and 522014Z-3748-1).

References

