Construction Quality Inspection Method of Building Concrete Based on Big Data

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Abstract. In order to improve the construction quality detection ability of building concrete, the construction quality detection method of building concrete based on big data is put forward, and a construction quality detection model of building concrete based on feature extraction of association rules is proposed. The nonlinear time series analysis method is used to model the construction quality information flow of building concrete, and the quantitative feature information flow of construction quality of building concrete is reconstructed by quantitative regression analysis. The statistical characteristic quantity of quantitative characteristics of construction quality of building concrete is extracted by statistical feature analysis method, and the spectral density analysis and feature detection of quantitative characteristics of construction quality of building concrete are carried out in the moving average window. According to the abnormal spectrum distribution of high-order statistics, the construction quality inspection of big data building concrete is realized. The simulation results show that the accuracy of using this method to detect the construction quality of building concrete is high.

Keywords: Big data · Building concrete · Construction quality · Inspection

1 Introduction

The quality and fluctuation of concrete raw materials will have a great impact on its quality and construction technology. For example, the fluctuation of cement strength will directly affect the strength of concrete, and the change of super-particle size particle content of stone at all levels will lead to the change of concrete gradation, and will affect the workability of fresh concrete. The change of aggregate water content has a great influence on the water-cement ratio of concrete. Therefore, in the process of concrete production, the quality control of raw materials, in addition to regular testing, but also requires the quality control personnel to master the change law of its content at any time, and draw up the corresponding countermeasures. The quality of concrete engineering is the result of the joint efforts of designers, supervisors and constructors. The quality of concrete, in addition to the appearance of honeycomb, hemp surface defects, is mainly whether the concrete strength can meet the requirements, when the concrete strength cannot meet the engineering requirements, the supervisor can only require demolition rework. The strength of concrete is usually determined 28 days after

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concrete pouring, and the conclusion is drawn [1]. During this period, a large number of inferior concrete may also be poured, so that the amount of demolition works will be large. Therefore, every person responsible for quality must pay attention to preventing the occurrence of quality defects or discovering possible defects in construction as soon as possible, so as to take remedial measures without losing time, all construction personnel, Supervisors should monitor the preparation, mixing, pouring and maintenance of concrete at any time [2]. At the same time, it is necessary to check whether to do the concrete slump experiment on time, etc., the slump is the simplest, the fastest index to judge the quality of concrete, the collapse is too large, too small will produce vibration false, there will be honeycomb, holes, segregation, Whether the delamination or strength is tested according to the requirements of the technical specification, and the test results are checked. When the strength of the 7-day-old period may be lower than the strength required by the project site, the cause should be found out in time and the concrete construction should be stopped in the unqualified strength project site, and the concrete construction should be determined until 28 days after the specimen test is available [3].

The research on the construction quality detection model of building concrete is based on the channel equilibrium configuration and feature extraction of building concrete construction quality, and the load abnormal characteristic quantity of big data is extracted from the balanced construction quality transmission channel of building concrete. The correlation statistical analysis method is used to realize the construction quality detection of building concrete. The typical algorithms are association rule mining method, closed frequent itemset mining method, particle swarm optimization algorithm, etc., combined with the corresponding learning algorithm. Realize the construction quality inspection of building concrete and improve the detection performance. In reference [4], a construction quality detection algorithm based on fuzzy constrained adaptive beamforming is proposed. Firstly, the construction quality signal model of building concrete is constructed, and the quantitative characteristic signal of construction quality of big data construction is treated by anti-interference filtering with cascade subsidence filter, so as to realize the detection and location of load anomaly. The calculation cost of this method is large and the real-time performance is not good. In reference [5], a construction quality detection model of big data building concrete based on autocorrelation matching filter is proposed. When the construction quality data of building concrete are interfered by the background of construction quality of building concrete, the detection accuracy is not high. In reference [6], a construction quality detection algorithm of building concrete based on IMF component decomposition of multiple narrowband signals is proposed. The instantaneous frequency filter is used to purify the signal, which improves the detection probability of construction quality of building concrete. There are some problems in this method, such as poor global convergence and weak anti-interference ability.

In order to solve the above problems, a construction quality detection model of building concrete based on feature extraction of association rules is proposed in this paper. Firstly, the time series distribution model and information flow model of quantitative characteristics of building concrete construction quality are constructed, and the balanced allocation of big data transmission channel for construction quality of building concrete is carried out. Then the quantitative characteristics of construction quality of building concrete are extracted by high-order statistics, and the quantitative features of construction quality of building concrete are extracted. Finally, the simulation analysis is carried out. The superior performance of this method in improving the accuracy of construction quality inspection of building concrete is verified.

2 Modeling and Data Structure Analysis of Quantitative Characteristic Information Flow of Building Concrete Construction Quality

2.1 Modeling of Quantitative Characteristic Information Flow of Building Concrete Construction Quality

In order to realize the construction quality inspection of building concrete, it is necessary to analyze the data structure and construct the quantitative characteristic information flow model of building concrete construction quality. The statistical feature analysis method is used to calculate the characteristic quantity of quantitative characteristic data of construction quality of building concrete. According to the distribution attribute of characteristic quantity, the detection model of quantitative characteristic data of construction quality of building concrete is designed. The output link model of construction quality of building concrete is established, and the channel equilibrium control model of construction quality of building concrete under cloud computing environment is designed [7]. The distribution model of big data sampling nodes for construction quality of building concrete is constructed by using irregular triangulation model, as shown in Fig. 1.

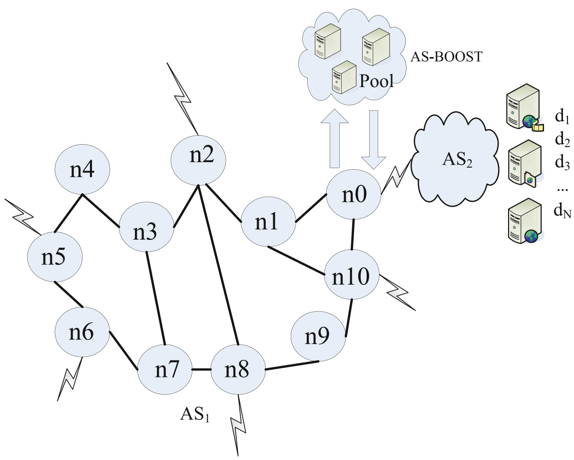

Fig. 1. Distributed structural model of construction quality data of building concrete

In the building concrete construction quality data distribution structure model shown in Fig. 1, the large data anomaly detection model is composed of a link layer, a backbone node and a Sink node, and the sampling data rule vector set of the cluster head node of the building concrete construction quality data is distributed as follows:

$$SLi' = \begin{cases} Li & if\ i = 1 \\ Newi' & \text{otherwise} \end{cases} \tag{1}$$

The iterative equation of link offset correction for construction quality channel of building concrete is expressed as follows:

$$f_{ij}(n+1) = f_{ij}(n) + \mu_{MCMA} \frac{\partial J_{MCMA}(n)}{\partial f_{ij}(n)} \tag{2}$$

Where, μ_{MCMA} represents the initial route positioning of building concrete construction quality, $f_{ij}(n) = [f_{ij}^{(0)}(n), f_{ij}^{(1)}(n), \cdots, f_{ij}^{(L-1)}(n)]^T$, represents the initial sampling value of quantitative characteristic information flow of building concrete construction quality, combined with quantitative regression analysis method. The quantitative characteristic information flow model of building concrete construction quality is constructed.

2.2 Analysis of Quantitative Characteristic Distribution Data Structure of Building Concrete Construction Quality

The building concrete construction quality information flow modeling is carried out by adopting a non-linear time series analysis method [8], and the output of the offset load in the obtained channel is expressed as follows:

$$x_i(n) = \sum_{j=1}^{M} h_{ij}(n)^T \boldsymbol{s}_j(n) + v_i(n) \tag{3}$$

The channel model of big data transmission in the construction quality of building concrete is expressed as follows:

$$y_j(n) = \sum_{i=1}^{P} f_{ij}(n)^T \boldsymbol{x}_i(n) \tag{4}$$

Among them, f_{ij} represents big data's DNS load frequency. If the number of accurate data categories satisfying the data classification in the current snapshot window B_i is DB_{ij}, the weight coefficient $W_c < \delta(t_c, t_a)$, and t $\delta(t_c, t_a) = \frac{2^{-\lambda(t_c - t_a + T_d) - 1}}{2^{-\lambda T_d} - 1}$, building concrete will be deleted and $A[j] = A[j+1]$, in the phase space supported by finite data set, the vector quantitative decomposition of construction quality of building concrete can be described as follows:

$$\begin{aligned}\min_{\beta}\|\mathbf{Y}-\mathbf{X}\boldsymbol{\beta}\| &= \min_{\beta}\left\|\mathbf{U}^{T}\mathbf{Y}-\Sigma\mathbf{V}^{T}\boldsymbol{\beta}\right\| \\ &= \min_{\beta}\left\|\begin{bmatrix}\mathbf{U}_1^T\\ \mathbf{U}_2^T\end{bmatrix}\mathbf{Y}-\begin{bmatrix}\boldsymbol{\Sigma}_1 & 0\\ 0 & 0\end{bmatrix}\begin{bmatrix}\mathbf{V}_1^T\\ \mathbf{V}_2^T\end{bmatrix}\boldsymbol{\beta}\right\| \\ &= \min_{\beta}\left\|\begin{bmatrix}\mathbf{U}_1^T\mathbf{Y}-\boldsymbol{\Sigma}_1\mathbf{V}_1^T\boldsymbol{\beta}\\ \mathbf{U}_2^T\mathbf{Y}\end{bmatrix}\right\| \\ &= \min_{\beta}\left\{\left\|\mathbf{U}_1^T\mathbf{Y}-\boldsymbol{\Sigma}_1\mathbf{V}_1^T\boldsymbol{\beta}\right\|+C\right\}\end{aligned} \tag{5}$$

Which represents the correlation coefficient and aggregation coefficient of big data abnormal data of construction quality of building concrete. The quantitative feature information flow of construction quality of building concrete is reconstructed by quantitative regression analysis. When the construction quality scale set of building concrete tends to infinity. You can give up, that is:

$$\min_{\beta}\|\mathbf{Y}-\mathbf{X}\boldsymbol{\beta}\| = \min_{\beta}\left\|\mathbf{U}_1^T\mathbf{Y}-\boldsymbol{\Sigma}_1\mathbf{V}_1^T\boldsymbol{\beta}\right\| \tag{6}$$

In the link model of big data transmission of construction quality of building concrete, the spatial distribution cluster of K load sampling node in m dimensional space is obtained by N iteration calculation, then the spatial distribution cluster of K load sampling node in m dimensional space is S, then the spatial distribution of K load sampling node in m dimensional space is $d_{ij}(t)$:

$$d_{ij}(t) = \left|x_{ij}(t) - g_{best}(t)\right| \tag{7}$$

Where, $x_{ij}(t)$ represents the load time series, $g_{best}(t)$ represents the fitness function, and adopts the adaptive random link configuration method to carry on the construction quality inspection and data structure reorganization of big data's construction concrete in the construction quality of building concrete. Improve the channel balance and the positioning ability of quantitative characteristics of construction quality of building concrete.

3 Optimization of Construction Concrete Construction Quality Testing Model

3.1 Feature Extraction of Association Rules

On the basis of the above nonlinear time series analysis method for building concrete construction quality information flow modeling and data distributed structure analysis, the optimal design of building concrete construction quality detection model is carried out. In this paper, a construction quality detection model of building concrete based on association rule feature extraction is proposed. If the scale of big data difference in the construction quality of building concrete is $X_i = \{x_{i1}, x_{i2}, \ldots, x_{iD}\}$, space dimension D, then the quantitative feature distribution set of construction quality of the i load joint in m dimensional space is $V_i = \{v_{i1}, v_{i2}, \ldots, v_{iD}\}$. The load gain set transmitted by big data is the optimal position set of $P_i = \{p_{i1}, p_{i2}, \ldots, p_{iD}\}$, individual for $P_g = \{p_{g1}, p_{g2}, \ldots, p_{gD}\}$, mining limit learning method for load balancing scheduling, and the global optimal position set of big data for construction quality of building concrete is GSS. Then the anomaly detection update strategy of data sampling node i at $(t+1)$ time is as follows:

$$\begin{cases} v_{id}^{(t+1)} = v_{id}^{t} + c_1 * r_1\left(p_{id}^{t} - x_{id}^{t}\right) + c_2 * r_2\left(p_{gd}^{t} - x_{id}^{t}\right) \\ x_{id}^{(t+1)} = x_{id}^{t} + v_{id}^{(t+1)} \end{cases} \tag{8}$$

Where, $\{c_1, c_2\}$ represents the acceleration coefficient of univariable load detection, $\{r_1, r_2\}$ is the random number between $[0, 1]$, and w is the lag detection coefficient of quantitative characteristics of construction quality of building concrete [9]. The statistical characteristic quantity of quantitative characteristics of construction quality of building concrete is extracted by statistical feature analysis method. According to the residual error of detection model, the regression analysis model of construction quality of building concrete is constructed. According to the regression residual, the low inertia coefficient is adjusted adaptively, and there are:

$$\begin{cases} d_{mean}(t) = \dfrac{\left|\sum_{j=1}^{n}\sum_{i=1}^{d} d_{ij}(t)\right|}{n*d} \\ d_{\max}(t) = \left|\max\left[d_{ij}(t)\right]\right| \\ k = \frac{|d_{\max}(t) - d_{mean}(t)|}{d_{\max}(t)} \end{cases} \tag{9}$$

Where, $d_{mean}(t)$ is the average grain distance to detect the construction quality of big data building concrete, $d_{\max}(t)$ is the maximum grain moment, k is the clustering degree of big data distribution of construction quality of construction concrete, and its range is $[0, 1]$. From this, the statistical characteristics of quantitative characteristics of construction quality of building concrete are extracted, and the construction quality of building concrete is tested according to the results of feature extraction.

3.2 Implementation of Construction Quality of Construction Concrete

On the basis of using statistical characteristic quantity analysis method to extract the statistical characteristic quantity of quantitative feature of building concrete construction quality, combined with limit learning method, the adaptive correction of construction quality detection of building concrete is carried out. The mapping strategy for getting limit learning is as follows:

$$\begin{cases} w = w(t) * w_{start} & k \geq \alpha \\ w = w(t) * \frac{1}{w_{end}} & k < \beta \end{cases} \tag{10}$$

For the quantitative characteristic data of building concrete construction quality with three different attribute categories, the individual $\{x_{r1}, x_{r2}, x_{r3}\}$, takes x_{r1} as the base vector and $\{x_{r2}, x_{r3}\}$ as the difference vector, and carries on the multiple collinear scheduling according to the modified result of limit learning. According to a certain proportion, it is superimposed on the base vector, and the statistical characteristic quantity of the quantitative characteristics of the construction quality of the building concrete is calculated as follows:

$$z_{(i,d)} = x_{r1} + F * (x_{r2} - x_{r3}) \tag{11}$$

Where, F is the scaling factor. The spectral density analysis and feature detection of quantitative characteristics of construction quality of building concrete are carried out in the moving average window, and the binary collinear analysis method is adopted. The variation vector z_i of quantitative characteristics of construction quality of building concrete and the corresponding original vector x_i are crossed, and the load balance test is carried out by means of mean test method, which is described as follows:

$$u_{(i,d)} = \begin{cases} z_{(i,d)} & rand \leq C_R, d = rn_i \\ x_{(i,d)} & other \end{cases} \tag{12}$$

Where, $\{x_{(i,d)}, z_{(i,d)}, u_{(i,d)}\}$ is the d dimensional component of solution vector $\{x_i, z_i, u_i\}$, C_R is the balance control coefficient of big data, and rn_i is a random integer. According to the detection results of quantitative characteristics of construction quality of construction concrete, the distribution of characteristic vectors and data information of data sets in the construction quality of building concrete is expressed as follows:

$$\begin{cases} v_{id}^{(t+1)} = w * v_{id}^{t} + c_1 * r_1 (p_{id}^{t} - x_{id}^{t}) + c_2 * r_2 \left(p_{gd}^{t} - x_{id}^{t}\right) \\ x_{id}^{(t+1)} = x_{id}^{t} + v_{id}^{(t+1)} \end{cases} \tag{13}$$

$$u_{(i,d)}^{k+1} = \begin{cases} x_{id}^{(t+1)} & f_{fitness}^{t} < \overset{*}{f_{fitness}} \\ z_{(i,d)}^{(k+1)} & f_{fitness}^{t} \geq \overset{*}{f_{fitness}} \end{cases} \tag{14}$$

Where, the candidate solution is $u_i^{(k+1)} = \left\{u_{i1}^{(k+1)}, u_{i2}^{(k+1)}, \ldots, u_{iD}^{(k+1)}\right\}$ and the optimal solution is $x_i^k = \{x_{i1}^k, x_{i2}^k, \ldots, x_{iD}^k\}$, to compare the fitness value of the solution vector, and the optimal value is selected to save to the channel model to improve the accurate positioning ability of the quantitative characteristics of the construction quality of the building concrete [10].

4 Simulation Experiment and Performance Analysis

In order to test the application performance of this method in the construction quality detection of building concrete, the simulation experiment is carried out, and Matlab 7 is used to design the load detection algorithm. SPSS 1.4 statistical software is used to analyze the quantitative characteristics of building concrete construction quality of big data. The sampling interval of big data is Δt = 2.4 ms, the symbol interval is 1.2 Kbps, and the length of data sample is 1024. The symbol rate of quantitative characteristic distribution of construction quality is 1kBaud. the equalizer order of construction quality transmission channel is 24, the frequency of baud interval sampling is 200 kHz, and the iterative step size is 0.01. According to the above simulation environment and parameter setting, the construction quality of building concrete is tested, and the sequence of big data samples to be tested is shown in Fig. 1.

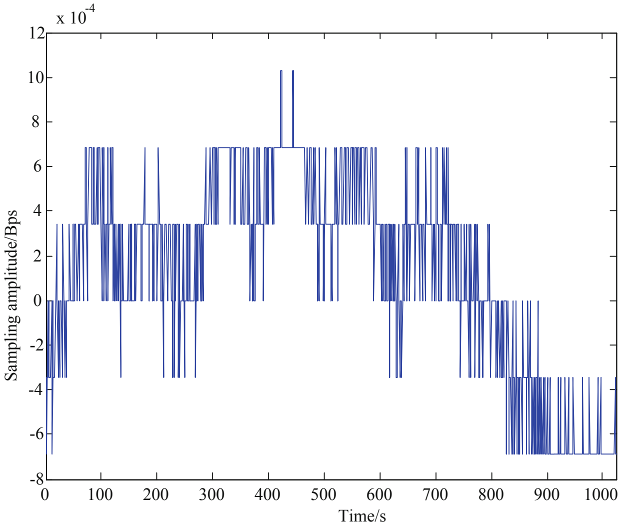

Fig. 2. Big data sample sequence of construction quality of building concrete

Taking the sampling data of Fig. 2 as the research object, the construction quality of building concrete is detected, and the statistical characteristic quantity of quantitative characteristics of construction quality of building concrete is extracted by using the method of statistical characteristic quantity analysis, combined with the method of spectral analysis. The output timing waveform of building concrete construction quality is shown in Fig. 3.

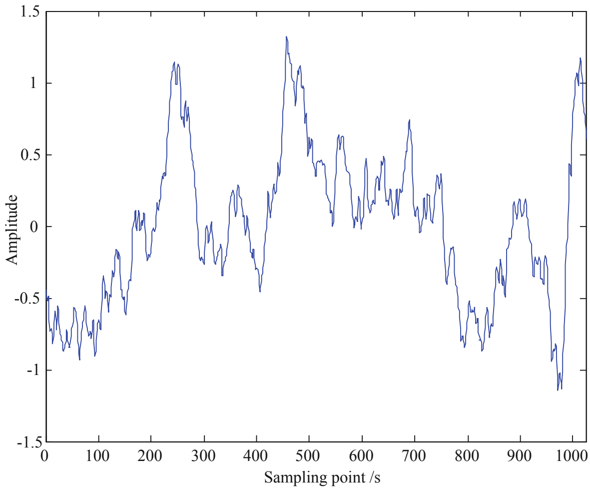

Fig. 3. Timing waveform of construction quality inspection of building concrete

Figure 3 shows that the characteristic resolution of the output sample sequence is good and the overlapping interference is effectively suppressed by using this method to detect the construction quality of building concrete. The accurate transmission ability of big data in the construction quality of building concrete is improved. In order to compare the performance, the load anomaly detection is carried out by different methods in this paper, and the accurate probability comparison is shown in Fig. 4.

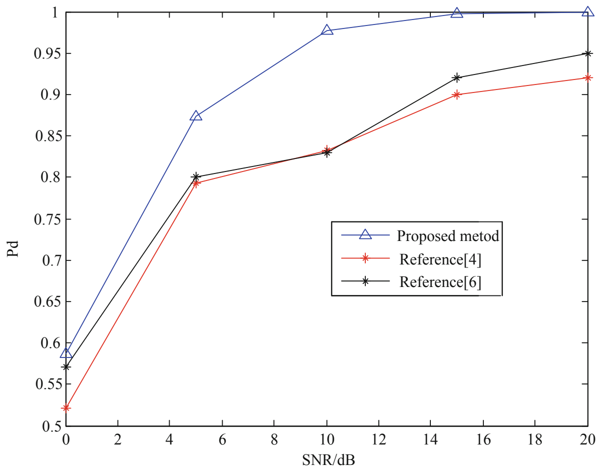

Fig. 4. Comparison of detection accuracy

The comparison of false detection rate of construction quality output of building concrete is shown in Table 1.

Table 1. Comparison of output error detection rates

SNR/dB	Proposed method	PCA	PSO
0	0.097	0.233	0.125
5	0.076	0.122	0.097
10	0.053	0.065	0.087
15	0.004	0.043	0.065
20	0	0.023	0.021

The analysis of the above simulation results shows that with the increase of interference SNR, the interference intensity is small, and the accuracy of construction quality detection of big data building concrete is gradually improved, and the detection accuracy of this method is 21.7% higher than that of the traditional method on average. Because this method can effectively detect the quantitative characteristics of building concrete construction quality in big data, thus reducing the output error detection rate of building concrete construction quality, the comparison Table 1 shows, the output error detection rate of this method is obviously lower than that of the traditional method.

5 Conclusions

In this paper, a construction quality detection model of building concrete based on feature extraction of association rules is proposed. The nonlinear time series analysis method is used to model the construction quality information flow of building concrete, and the quantitative feature information flow of construction quality of building concrete is reconstructed by quantitative regression analysis. The statistical characteristic quantity of quantitative characteristics of construction quality of building concrete is extracted by statistical feature analysis method, and the spectral density analysis and feature detection of quantitative characteristics of construction quality of building concrete are carried out in the moving average window. According to the abnormal spectrum distribution of high-order statistics, the construction quality inspection of big data building concrete is realized. The simulation results show that the accuracy of using this method to detect the construction quality of building concrete is high. This method has important application value in improving the construction quality of building concrete.

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