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Retraction

Retracted: Quality Control Strategy and Evaluation Algorithm for Noncontact Instrument Testing

International Transactions on Electrical Energy Systems

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This article has been retracted by Hindawi following an investigation undertaken by the publisher [1]. This investigation has uncovered evidence of one or more of the following indicators of systematic manipulation of the publication process:

(1) Discrepancies in scope
(2) Discrepancies in the description of the research reported
(3) Discrepancies between the availability of data and the research described
(4) Inappropriate citations
(5) Incoherent, meaningless and/or irrelevant content included in the article
(6) Manipulated or compromised peer review

The presence of these indicators undermines our confidence in the integrity of the article's content and we cannot, therefore, vouch for its reliability. Please note that this notice is intended solely to alert readers that the content of this article is unreliable. We have not investigated whether authors were aware of or involved in the systematic manipulation of the publication process.

Wiley and Hindawi regrets that the usual quality checks did not identify these issues before publication and have since put additional measures in place to safeguard research integrity.

We wish to credit our own Research Integrity and Research Publishing teams and anonymous and named external researchers and research integrity experts for contributing to this investigation.

The corresponding author, as the representative of all authors, has been given the opportunity to register their agreement or disagreement to this retraction. We have kept a record of any response received.

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[1] X. Jin and J. Tang, "Quality Control Strategy and Evaluation Algorithm for Noncontact Instrument Testing," *International Transactions on Electrical Energy Systems*, vol. 2023, Article ID 5080240, 10 pages, 2023.

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Research Article

Quality Control Strategy and Evaluation Algorithm for Noncontact Instrument Testing

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The test quality of noncontact instruments is an important issue that has aroused social concern at present, which is also widely used in the power quality management of telecommunication systems. The fuzzy logic algorithm can be used in power quality testing to analyze the power quality of electrical equipment. Based on the advantage of the fuzzy logic algorithm, this paper studied the quality control strategy and evaluation algorithm of noncontact instrument testing and drew a conclusion. In terms of the investigation on the safety of power quality measurement, it was concluded that the method of noncontact instrument testing power quality improved the safety of voltage quality, current quality, power supply quality, and power consumption quality. In the investigation of the accuracy of the power quality measurement, it was concluded that the noncontact instrument was used to measure power quality, which greatly improved the accuracy of measurement. In terms of the investigation on the rapidity of the power quality measurement, it was concluded that the use of the noncontact instrument to test power quality could greatly improve the rapidity of current quality measurement and that the rapidity of the power quality measurement could be improved by more than 70%. In the aspect of economic investigation of the power quality measurement, it was concluded that the use of the noncontact instrument to test power quality could greatly improve the economic efficiency of the power quality measurement. In the aspect of fuzzy logic evaluation in power quality management, it was concluded that most of the power quality grades of the selected research objects were excellent. Therefore, the fuzzy logic method was very meaningful for power quality evaluation.

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1. Introduction

The traditional power quality testing method usually uses a harmonic detection method. This detection method often injects a lot of harmonics into the power system because of the nonlinearity of the rectifier and frequency converter, which causes harmonic pollution, brings adverse effects to the environment, and causes panic among the masses. In order to avoid environmental pollution, improve the testing effect of power quality testing methods, and enhance the safety, rapidity, and convenience of testing, it is necessary to study the control strategy and evaluation algorithm of noncontact instrument testing power quality with a fuzzy logic method.

At present, there are many research studies on quality testing. Squara et al. introduced the main measurement quality standards and verification procedures for measuring instrument characteristics [1]. Grano et al. used the test cases of source code quality indicators for lightweight evaluation of effectiveness [2]. Bennert et al. studied the performance index of asphalt mixture determined by the indirect tensile test in the quality control test of New Jersey [3]. Manta et al. studied the statistical quality control method for the validation of the immunochromatographic rapid detection kit based on gold nanoparticles [4]. Yeh and Chen improved the test quality of integrated circuits to achieve the repeated test application of zero defect product requirements [5]. The research of quality testing mostly focuses on the methods and strategies of quality control, and there is little research on noncontact instruments.

In recent years, the noncontact instrument has been widely concerned by scholars and has also been deeply studied. Lanza et al. analyzed the difference between the intraocular pressure assessment with contact and noncontact devices [6]. Goyal et al. studied the placement strategy of noncontact sensors for condition monitoring of rotating machine components [7]. Gulino et al. used gas-coupled laser acoustic testing for noncontact ultrasonic testing [8]. Pelivanov et al. used noncontact photoacoustics to identify the molecular fingerprints of nanoparticles in complex media [9]. Singhvi et al. studied a microwave-induced thermoacoustic imaging system with noncontact ultrasonic testing [10]. The research of noncontact instruments is mostly on ultrasonic testing, but there is little research on quality testing.

In order to improve the effect of power quality testing, this paper designed a method of noncontact instrument testing quality based on the fuzzy logic method and explained its control strategy and evaluation method. At the same time, this test method was compared with the traditional power quality test method. The safety, accuracy, rapidity, and economy of the power quality test were selected as the evaluation indicators, and finally, the feasibility conclusion was drawn. This paper provided a theoretical and practical basis for the analysis of control strategies and evaluation algorithms for the testing quality of noncontact instruments.

2. Noncontact Instrument Testing Technology

Noncontact measurement is a measurement technology based on photoelectric, electromagnetic, and ultrasonic technology. It can obtain the surface characteristic information of the object without the sensor of the instrument contacting the surface of the object being measured [11].

Typical noncontact measurement methods can be divided into optical and nonoptical ones, as shown in Figure 1.

Optical methods include structured light, laser triangulation, laser ranging, interferometry, and image analysis [12]. Nonoptical methods include acoustic measurement, magnetic measurement, X-ray scanning, and eddy current measurement. However, the research in this paper mainly focuses on the detection of power quality management in the telecommunication system, so the eddy current measurement method is mainly studied.

2.1. Eddy Current Method. According to the principle of electromagnetic induction, when the metal conductor is placed in the alternating magnetic field or the magnetic field where the magnetic field lines intersect, there would be eddy currents in the conductor, which are called eddy currents [13]. The eddy current sensor is based on the effect of the eddy current on the sensor. It has high reliability, high sensitivity, fast response time, and other characteristics. A typical device is a cable core device, and its structure is shown in Figure 2.

The basic principle is that the coil sensor uses alternating current to create a magnetic field, which induces current in the metal conductor. The magnetic field generated by the induced current weakens the magnetic field generated by the coil and affects the inductance of the coil. With the change in the induced current, the distance between the metal conductor and the coil changes and the inductance of the coil changes accordingly. The distance between the coil and the conductor can be measured by the change in inductance.

The vortex current measurement method is characterized by using a small eddy current sensor, which is very reliable in continuous operation and can measure displacement, velocity, voltage, thickness, surface temperature, material damage, etc. Typical sensors are speed sensors and eddy current thickness sensors. The disadvantage of eddy current measurement technology is that the measured object must be a metal conductor with a certain thickness and smooth surface, and other metal end faces cannot be used around the sensor coil.

2.2. Development Trend of Noncontact Instrument Testing Technology. At present, the development of noncontact instrument testing technology is moving towards the direction of high integration, high precision, high accuracy, and high intelligence, as shown in Figure 3.

2.2.1. Highly Integrated. The principle of noncontact measurement technology has been mature, but most of the measuring products at this stage have a single function and cannot achieve multifunction noncontact measuring instruments [14]. High integration is realized in the stereo vision room, such as integrated noncontact temperature measurement, displacement measurement, and vibration measurement, which greatly improves the practicability of the product. This would help reduce the purchase cost of measuring instruments for enterprises and accelerate the promotion and application of noncontact measurement technology.

2.2.2. High Precision and Accuracy. The current situation of noncontact measurement technology is not even as accurate as that of contact measurement technology. This requires the development of high-precision optical and electronic components as well as excellent analysis and processing software. Only in this way, the accuracy of measuring instruments in terms of shell cost can be improved, and finally, an all-round product higher than that of contact measurement technology can be realized.

2.2.3. Reduced Requirements for the Working Environment. Noncontact measurement technology is mainly based on optical elements. The harsh environment has a great impact on the working accuracy and accuracy of optical elements. In the bad working environment, optical measuring instruments cannot even work normally. This is a technical problem that needs to be solved urgently, and it is also the development direction of noncontact measurement technology.

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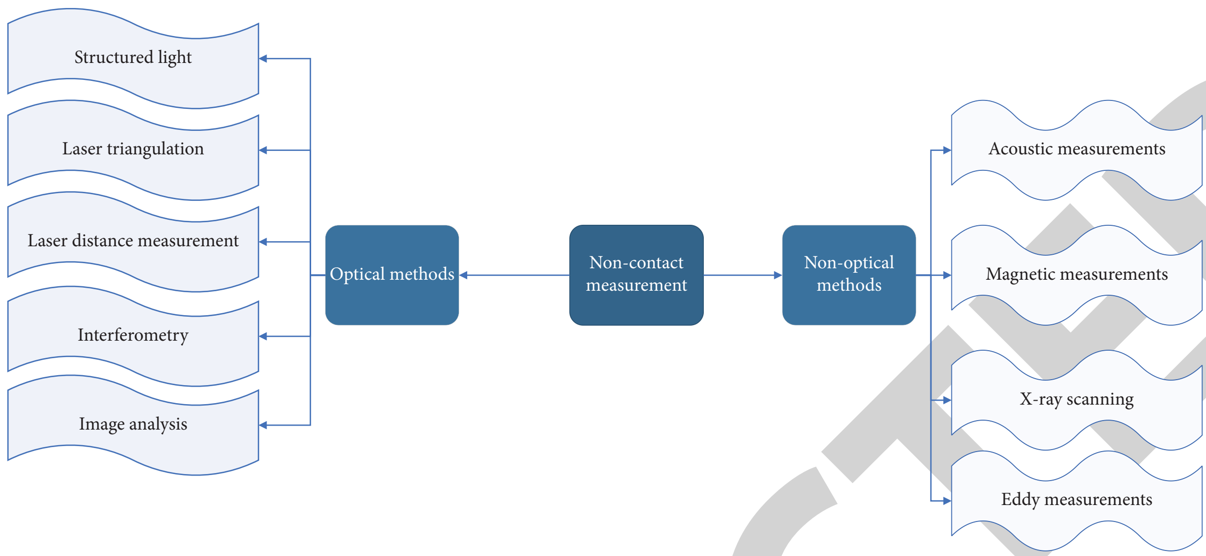

Figure 1: Noncontact measurement methods.

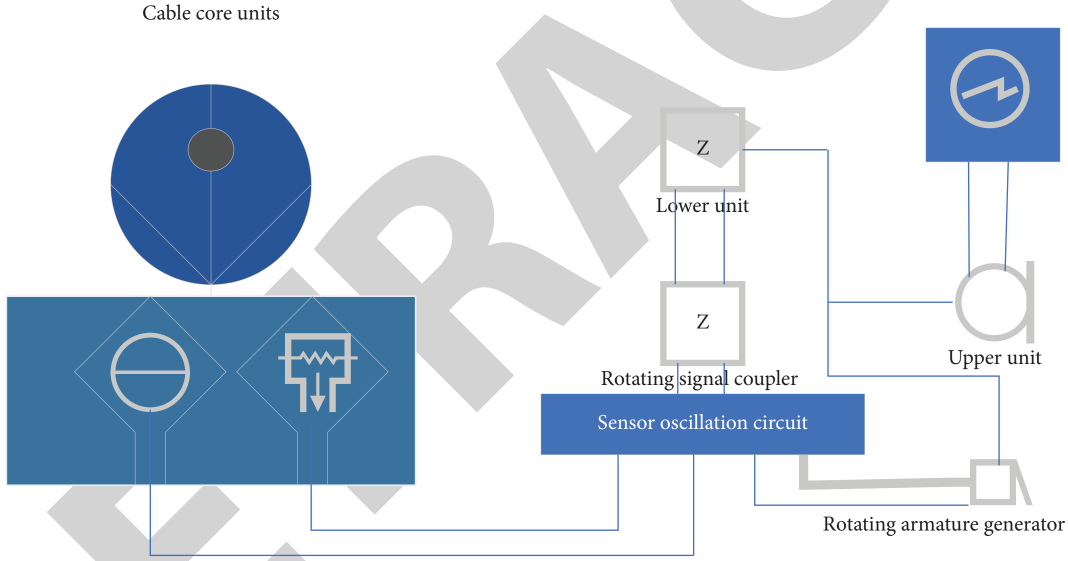

Figure 2: Structure of the cable core unit.

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2.2.4. Highly Intelligent. With the rapid development of industrial technology, measuring instruments need to conduct highly intelligent analysis of the measured object, so it is necessary to develop noncontact measurement technology in the direction of intelligence. For example, the measured object can be intelligently analyzed, and the noncontact measuring instrument with the most appropriate measurement method can be automatically selected.

3. Quality Control Strategy for Noncontact Instrument Testing

In the noncontact instrument testing method, technicians conduct external inspection and then conduct thorough inspection with appropriate instruments. Instrumental testing usually involves the use of testing tools and other instruments to examine the structure of objects. The value determined must conform to the standard manufacturing specification of the object. The use of the instrument must also take into account the classification of nondestructive testing technology, the practical application of leak detection, the nature and function of the object structure, the need to maintain the integrity of the object structure, and the need to prevent damage to the object structure. Nondestructive testing technology includes X-ray technology, ultrasonic technology, and electromagnetic induction technology. The difference between nondestructive testing and destructive testing is large, so standardized methods are usually used to study the structure of objects. After this basic activity, various pressure parts of the instrument can be tested and recorded to verify whether they meet the standard design and manufacturing specifications of the object. Once the information about power quality problems is identified and analyzed, effective management technology must be

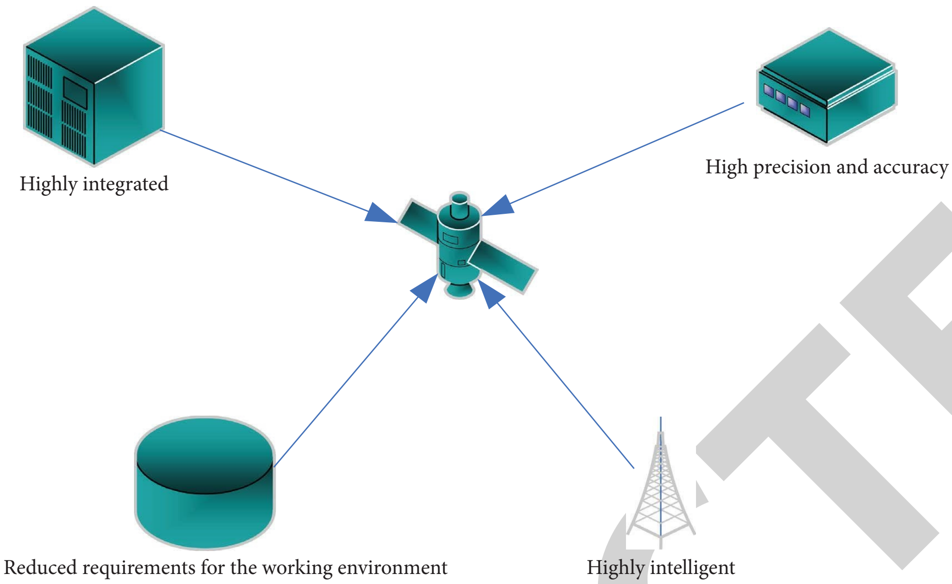

FIGURE 3: Trends in noncontact instrumentation test technology.

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used to eliminate or suppress this information. The control method used is closely related to the type of power quality problems and control equipment.

Some constant voltage control devices, such as shunt capacitors, shunt inductors, and transformer tap changers, are traditionally mechanical. They have slow response to power quality problems, inaccurate adjustment, and limited control ability. The range of control strategies is very wide, which ranges from very simple open-loop control strategies to advanced control strategies, such as fuzzy control and intelligent control.

The power quality control device based on power electronics technology is connected to the power grid through the inverter [15]. At present, the most widely used control method is the inverter control technology, which can actively or passively control the four displays between the energy storage equipment and the power grid by adjusting the control angle and modulation pulse width. It can control the power exchange and reactive power and effectively suppress the harmonics on the alternating current side. At present, the power quality interference signal generated from this is being studied and applied to the most widely used control method to determine the final inverter starting signal.

The application of the fuzzy logic control method can improve this situation. When designing the controller according to the "frequency domain method" of classical control theory and the "time-domain method" of modern control theory, it is necessary to know the precise mathematical model of the controlled object [16, 17]. Although adaptive and self-tuning control greatly reduces the requirements for modeling accuracy, it requires a large number of prior data and online model identification with complex algorithms and high computational complexity, which limits its application. As an advanced control method, fuzzy control does not need an accurate system mathematical model. By using fuzzy description of system characteristics, the cost of obtaining dynamic and static system characteristics can be greatly reduced. Fuzzy control is highly reliable and insensitive to external disturbances, process parameter changes, and nonlinearity. However, the characteristic of fuzzy control is a steady-state error, which is very sensitive to small fluctuations around the operating point. By combining other control technologies with fuzzy control, such as variable structure control and artificial neural network, the performance of fuzzy control can be improved.

4. Evaluation Algorithm for Testing Quality of Noncontact Instruments

4.1. Fuzzy Logic in Power Quality Management. The existing equipment for monitoring and collecting power quality data does not have enough detailed threshold parameters. Due to the limited capacity of this kind of equipment, the effective information about basic fault characteristics is easily submerged by the data of transient faults [18, 19]. In order to effectively and accurately classify the transient power quality interference, one of the main challenges is to develop a classifier that can accurately describe the relationship between the interference characteristics and interference types. The power quality disturbance signal itself is nonlinear and nonuniform, so artificial intelligence technologies such as fuzzy logic are widely used in the development of disturbance classifiers to flexibly describe the natural relationship between complex nonlinearity and disturbance types in power quality disturbances [20, 21]. However, fuzzy logic is a simulation of the human fuzzy thinking process, and it is difficult to generalize and learn the knowledge of fuzzy logic, so the process of parameter estimation of a fuzzy classifier is very complex; it is not easy to achieve optimal results. In addition, with the increase in error types and the improvement of intelligent optimization methods, the number of fuzzy variables, fuzzy rules, and classification parameters required by the fuzzy classifier is also increasing. Although this provides a classification effect, it increases the size of the classifier and reduces classification efficiency. In order to solve these problems, fuzzy logic can be used to derive various power quality indicators [22, 23].

4.2. Quality Evaluation Algorithm. If q is the true correlation of detection quality, the number of each correlation mark follows the binomial distribution. The likelihood function is as follows:

$$y_1 = \prod_{l=0}^{j} \left(\pi_{ql}^{(k)}\right) n_{il}^{(k)}. \tag{1}$$

In the formula, $n_{il}^{(k)}$ represents the mass of the object.

The quality inspection of all objects is independent of each other. Therefore, when the condition of $T_{iq} = 1$ is known, the likelihood function of the number of correlation marks of the detection quality i is as follows:

$$y_2 = \prod_{K=0}^{K} \prod_{l=0}^{j} \left(\pi_{ql}^{(k)}\right) n_{il}^{(k)}. \tag{2}$$

The likelihood function under the condition that the restrictions of $T_{iq} = 1$ are unknown is

$$y_3 = \prod_{j=1}^{J} \left\{ P_j \prod_{k=1}^{K} \prod \left(\pi_{jl_{l=1}}^{(k)^J} \right) n_{il}^{(k)} \right\}^{T_{ij}}. \tag{3}$$

In the formula, p_j represents the probability of randomly selecting the correlation evaluation task whose true correlation is j.

Since all objects are independent of each other, the likelihood function of full data is as follows:

$$y_4 = \prod_{i=1}^{I} \prod_{j=1}^{J} \left\{ P_j \prod_{k=1}^{K} \prod \left(\pi_{jl_{l=1}}^{(k)^J} \right) n_{il}^{(k)} \right\}^{T_{ij}}. \tag{4}$$

If the values of $n_{il}^{(k)}$ and T_{ij}, p_j and possible probability values in formula (4) are known, the maximum likelihood estimation can be calculated to obtain the estimated value of each variable:

$$\pi_{jl}^{(k)} = \frac{\sum_i T_{ij} n_{il}^{(k)}}{\sum_l \sum_i T_{ij} n_{il}^{(k)}}. \tag{5}$$

When the probability value $P_j\,(j = 1, \ldots, J)$ is unknown, the value of P_j can be estimated:

$$P_j = \frac{\sum_i T_{ij}}{I}. \tag{6}$$

When the object quality error rate $\left\{\pi_{jl}^{(k)}\right\}$ and the edge probability $\left\{P_j\right\}$ are known and the true correlation of the evaluation task is unknown, Bayesian theory can be used to obtain the estimated value of the indicator variable $T_{ij}\,(j = 1, \ldots, J)$. The prior probability $P(T_{ij} = 1) = P_j$ is known. If the correlation result data of all evaluation tasks are known, the following formula can be obtained according to Bayesian theory:

$$P\left(T_{ij} = 1|\text{data}\right) = \frac{\prod_{k=1}^{K} \prod_{l=1}^{J} \left(n_{jl}^{(k)}\right) n_{il}^{(k)} P_j}{\sum_{q=1}^{J} \prod_{k=1}^{K} \prod \left(\pi_{jl}^{(k)}\right) n_{il}^{(k)} P_q}. \tag{7}$$

If the true correlation of each assessment task is not known in advance, that is, the correlation answer $T_{ij}\,(j = 1, \ldots, J)$ is unknown, the likelihood function of the whole data is as follows:

$$y_5 = \prod_{i=1}^{I} \left(\sum_{j=1}^{J} P_j \prod_{k=1}^{K} \prod \left(\pi_{jl_{l=1}}^{(k)^J} \right) n_{il}^{(k)} \right). \tag{8}$$

5. Evaluation of the Quality Evaluation Effect

The fuzzy logic in power quality management of the telecommunication system has great advantages in measuring the quality of noncontact instruments, so it can greatly improve the performance of quality testing. Based on this, this paper analyzes the measurement results of noncontact instruments from the perspective of safety, accuracy, rapidity, and economy. It is generally believed that power quality includes voltage quality, current quality, power supply quality, and power consumption quality, so this paper analyzes them from these four perspectives. The paper compares the noncontact instrument testing method with the traditional testing method. In order to investigate, the paper selects the residents' electrical equipment for investigation and records the results in Table 1.

The electrical equipment selected in this paper is common high-power electrical equipment in residents' homes, and its investigation has certain reference significance. The experimental data in this paper can provide a certain reference value for the safety of electricity consumption in residents' lives. The survey data in this paper are the average value of each electric equipment.

5.1. Safety of Power Quality Measurement. The risk of electricity use is a safety problem that residents are easy to encounter in life. In the process of the power quality measurement, unsafe events are more likely to occur to cause serious consequences. In order to avoid the occurrence of unsafe events, it is extremely necessary to investigate the safety of the power quality measurement [24]. This paper investigates the safety of the power quality measurement and records the results in Figure 4.

Compared with traditional testing methods, the noncontact instrument testing power quality method proposed in this paper improves the security of voltage quality, current quality, power supply quality, and power quality so as to promote the security of the power quality measurement. The safety of the voltage quality measurement is improved by 25.5%. The safety of the current quality measurement is improved by 26%. The security of the power supply quality measurement is improved by 26.1%. The safety of the electricity quality measurement is improved by 30.7%. The

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Table 1: Electricity consumption equipment for residents.

Residents	Air conditioners	Electric water heaters	Induction cookers	Microwave ovens
Resident 1	4	1	2	2
Resident 2	3	1	3	1
Resident 3	1	1	1	1
Resident 4	2	1	2	2

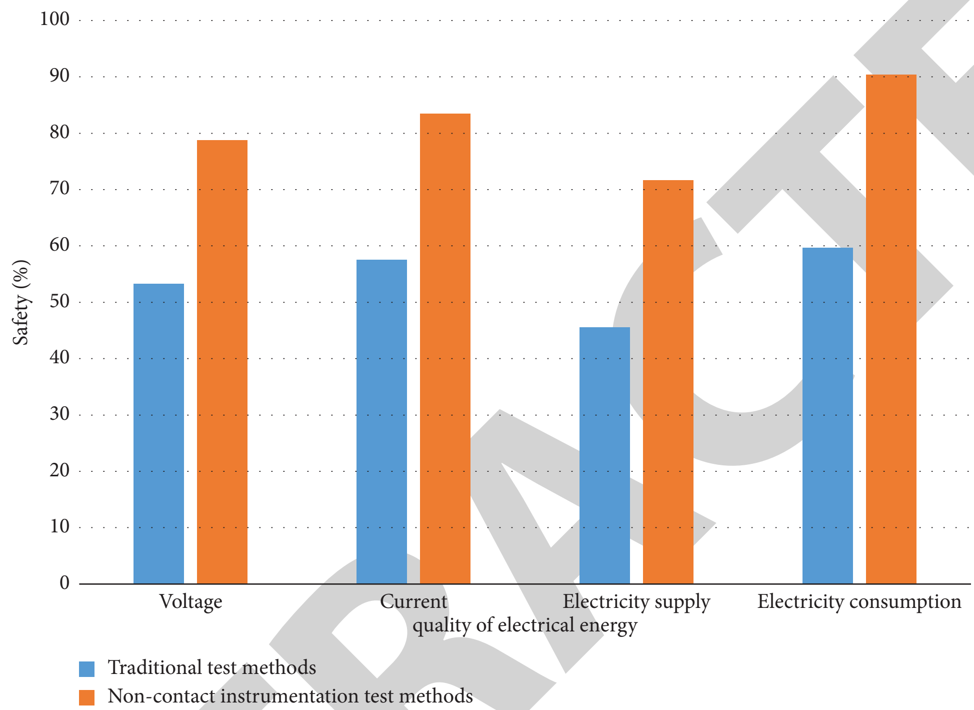

Figure 4: Safety of the power quality measurement.

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safety improvement effect of the power quality measurement is the best, because the use of noncontact instruments avoids the interference of human factors, thus improving the reliability of power quality.

5.2. Accuracy of Power Quality Measurement. If the measurement of power quality is not accurate, it would lead to misjudgment, which would bring adverse effects to the measurement of power quality. Therefore, this paper selects the accuracy of the power quality measurement as the evaluation index of the power quality measurement and records the results in Figure 5.

The accuracy of the power quality measurement is related to whether the power can be reasonably judged and planned according to power quality so as to achieve good measurement results. Among them, the accuracy of the voltage quality measurement is improved from 59.5% of the traditional measurement method to 82.9% of the noncontact instrument method for measuring power quality, the accuracy of the current quality measurement is improved from 57.1% of the traditional measurement method to 78.4% of the noncontact instrument method for measuring power quality, the accuracy of the power supply quality measurement is improved from 62.4% of the traditional measurement method to 89.2% of the noncontact instrument measurement method, and the accuracy of the power quality measurement is improved from 49.7% of the traditional measurement method to 71.6% of the noncontact instrument method. In general, the accuracy of the power quality measurement is greatly improved by using the noncontact instrument to measure power quality.

5.3. The Rapidity of Power Quality Measurement. If the power quality can be measured quickly, it would have a positive impact on the electricity measurement. The faster the measurement speed, the better it can meet the needs of current life. Based on this, this paper tests the rapidity of the power quality measurement and records the results in Figure 6.

The rapidity of the power quality measurement is kept below 70% when using traditional measurement methods, and it is more in the range of 50% to 60%. It shows that the traditional measurement method is not fast enough to measure power quality, which cannot meet the public's demand for the rapidity of the power quality measurement. However, when using the noncontact instrument to test power quality, the speed of the power quality measurement is improved by more than 70%. Among them, the rapidity of

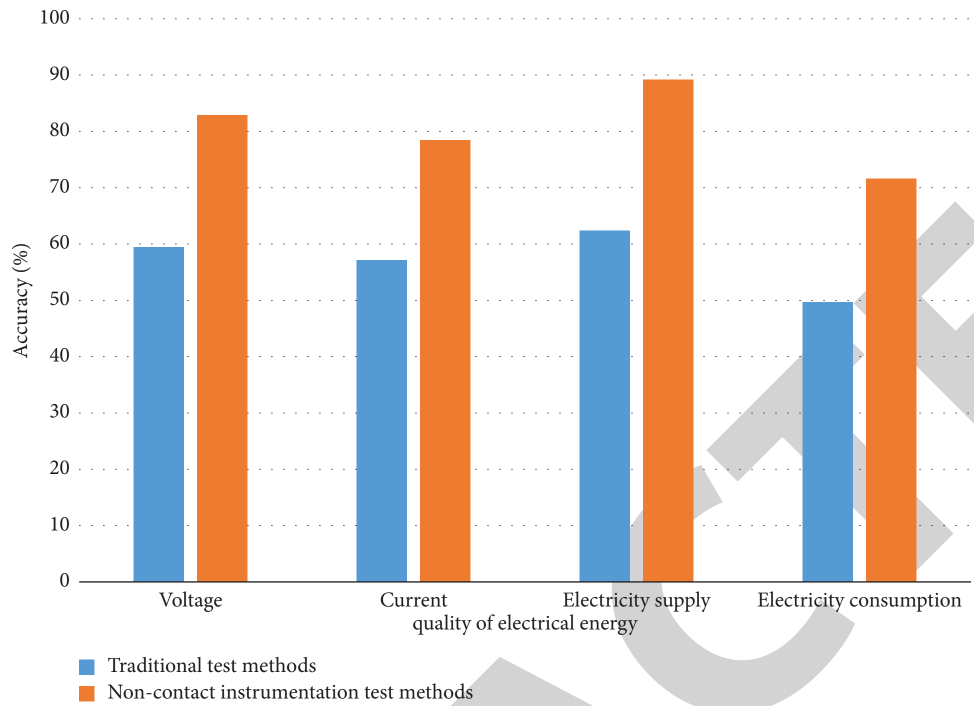

Figure 5: Accuracy of power quality measurement.

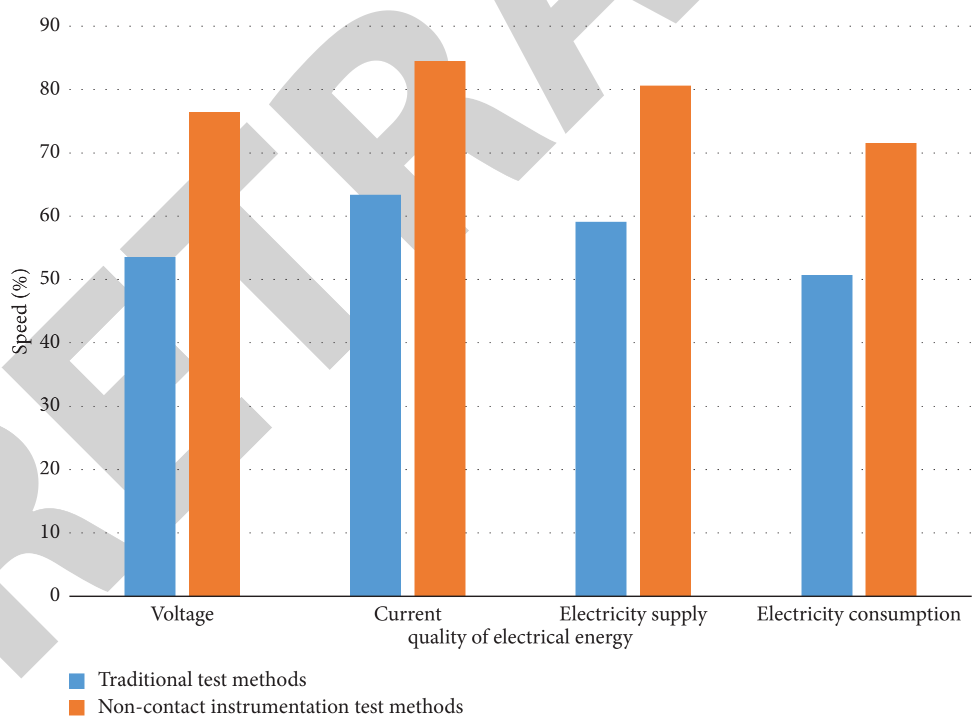

Figure 6: Speed of measurement of power quality.

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the current quality measurement is increased by 21.1%, and the improvement effect is the best. Therefore, the use of the noncontact instrument to measure power quality can greatly improve the rapidity of the current quality measurement.

5.4. Economy of Power Quality Measurement. Economy refers to the lowest resource consumption when obtaining certain quantity and quality of products, services, and other achievements in the process of organizing business activities. The higher the economy, the better the measurement

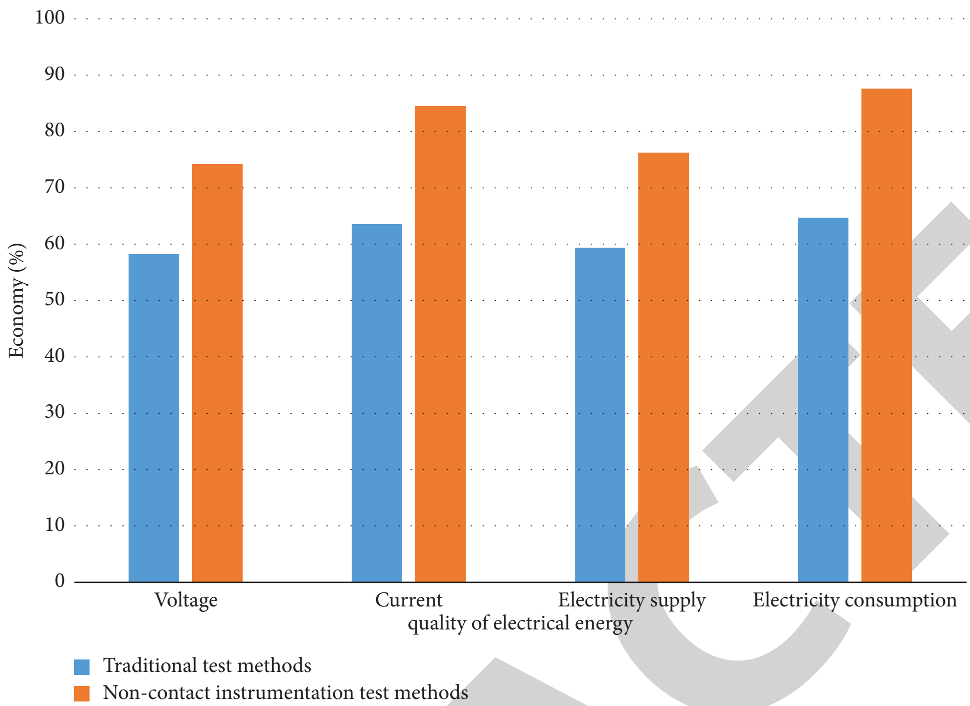

Figure 7: Economy of power quality measurement.

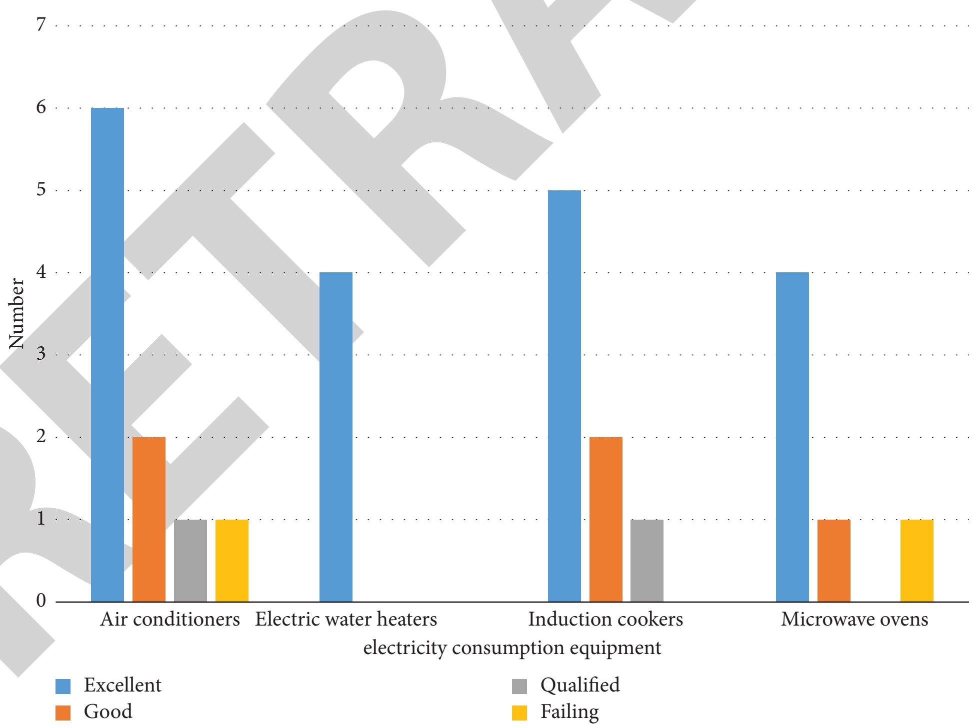

Figure 8: Fuzzy logic evaluation in power quality management.

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method can meet the needs of the public, and the results are recorded in Figure 7.

The traditional power quality measurement method is not economical. The test economy of voltage, current, power supply, and power quality is not high, which is below 70%. However, the economy of power quality testing is greatly improved when using the noncontact instrument to test power quality. Among them, the economy of the voltage quality measurement is improved from 58.2% of traditional measurement methods to 74.2% of the noncontact instrument measurement of power quality, the economy of the current quality measurement is improved from 63.5% of the traditional measurement method to 84.5% of the noncontact instrument measurement method of power quality, the economy of the power supply quality measurement is improved from 59.3% of the traditional measurement method to 76.2% of the noncontact instrument measurement method, and the economy of the power quality measurement is improved from 64.7% of the traditional measurement method to 87.6% of the noncontact instrument method. In conclusion, the use of the noncontact instrument to test power quality can greatly improve the economy of the power quality measurement.

5.5. Fuzzy Logic Evaluation in Power Quality Management. The fuzzy logic method can be used to evaluate power quality. The electrical equipment can be classified into air conditioners, electric water heaters, induction cookers, and microwave ovens. They are classified according to the level of excellent, good, qualified, and unqualified, and the results are recorded in Figure 8.

The fuzzy logic algorithm is used to evaluate the air conditioner, electric water heater, induction cooker, and microwave oven. It is found that, among the ten air conditioners, the power quality of six air conditioners is excellent, the power quality of two air conditioners is of good grade, the power quality of one air conditioner is qualified, and the power quality level of only one air conditioner is unqualified. The power quality of the four electric water heaters is excellent. In the survey of induction cookers, the power quality of five induction cookers is excellent, the power quality of two induction cookers is of good grade, the power quality of one induction cooker is qualified, and there is no induction cooker with unqualified power quality. In the survey of microwave ovens, there are four microwave ovens with excellent power quality, the power quality of one microwave oven is qualified, and the power quality of one microwave oven is unqualified. To sum up, the power quality level of the research object selected in this paper is mostly excellent, and only the power quality of two pieces of electrical equipment is unqualified.

6. Conclusions

In order to improve the quality of power measurement, this paper first introduced the basic method of the noncontact instrument measurement and then proposed a noncontact instrument measurement method of power quality. The quality control strategy and the evaluation algorithm of noncontact instrument testing were explained and applied to the measurement of power quality. They were also compared with those of the traditional power quality measurement method, and the final conclusion was drawn. Compared with the traditional power quality measurement methods, the noncontact instrument method proposed in this paper could greatly improve the safety, accuracy, rapidity, and economy of the power quality measurement. In the evaluation and analysis of the electrical equipment by the fuzzy logic algorithm, it was concluded that only two pieces of electrical equipment were at the unqualified level. In general, the use of the fuzzy logic algorithm makes the measurement of power quality by using noncontact instruments more convenient and fast.

Data Availability

The data that support the findings of this study are available from the corresponding author upon reasonable request.

Conflicts of Interest

The authors declare that they have no conflicts of interest.

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